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Meteorological Processor for Regulatory Models (MPRM-1.1) User´s Guide

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16. ABSTRACT

Version 1.1 of MPRM provides a general purpose computer processor for organizing available meteorological data into a format suitable for use by air quality dispersion models. Specifically, the processor is designed to accommodate those dispersion models that have gained EPA approval for use in regulatory decision making.

MPRM can be envisioned as a three stage system. The first stage retrieves the meteorological data from computer tape or disk files and processes the data through various quality assessment checks. The second stage collects all data available for a 24-hour period (upper air observations, hourly surface weather observations, and data collected as part of an on-site meteorological measurement program) and stores these data in a combined (merged) format. The third stage reads the merged meteorological data and performs the necessary processing to produce a meteorological data file suitable for use by the specified dispersion model.

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METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS
(MPRM-1.1)
User's Guide

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AFFILIATION

John S. Irwin and Roger W. Brode are on assignment from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

PREFACE

The Atmospheric Sciences Research Laboratory (ASRL) conducts a research program in the physical sciences to detect, define, and quantify the effects of air pollution on urban, regional, and global atmospheres and the subsequent impact on water quality and land use. This includes research and development programs designed to quantify the relationships between emissions of pollutants from all types of sources, and air quality and atmospheric effects. Within ASRL, the Meteorology and Assessment Division (MAD) researches programs in environmental meteorology to describe the roles and interrelationships of atmospheric processes and airborne pollutants in effective air and land resource management.

One particular area of research performed by MAD is development, evaluation, validation, and application of models for air quality simulation, photochemistry, and meteorology. The models must be able to describe air quality and atmospheric processes affecting the dispersion of airborne pollutants on scales ranging from local to global. Within MAD, the Environmental Operations Branch adapts and evaluates new and existing meteorological dispersion models and statistical technique models, tailors effective models for recurring user application, and makes these models available through EPA's User's Network for Applied Modeling of Air Pollution (UNAMAP) system.

The Meteorological Processor for Regulatory Models (MPRM-1.1) is a general purpose computer processor for organizing available meteorological data into a format suitable for use by dispersion models that have been approved by the EPA for use in regulatory decision making. A unique feature of the processor is the ability to employ user collected meteorological measurements as well as those routinely collected by the National Weather Service (NWS).

This first version of the meteorological processor (MPRM-1.1) will support the following dispersion models listed in the Guideline on Air Quality Models (Revised) (EPA, 1986), as well as three screening models:

- Those requiring RAMMET formatted data: BLP, RAM, ISCST, MPTER, CRSTER, and COMPLEX1.
- Those requiring STAR formatted data: CDM (with either 16 or 36 wind direction sectors), ISCLT, and VALLEY (long term).
- Those requiring special formats: CALINE-3 and RTDM (default).

The processor was specifically designed to allow ready adaptation to new storage formats for meteorological data, to new dispersion models, and to new processing assumptions.

Although attempts are made to thoroughly check computer programs with a wide variety of input data, errors are occasionally found. Revisions may be obtained as they are issued by completing and returning the form on the last page of this guide.

Comments and suggestions regarding this publication should be directed to:

Chief, Environmental Operations Branch
Meteorology and Assessment Division (MD-80)
Environmental Protection Agency
Research Triangle Park, NC 27711

Technical questions regarding use of the processor may be asked by calling (919)541-4564. Users within the Federal Government may call Federal Telecommunications System (FTS) 629-4564. Copies of the user's guide are available from the National Technical Information Services (NTIS), Springfield, VA 22161.

ABSTRACT

Version 1.1 of MPRM provides a general purpose computer processor for organizing available meteorological data into a format suitable for use by air quality dispersion models. Specifically, the processor is designed to accommodate those dispersion models that have gained EPA approval for use in regulatory decision making.

MPRM can be envisioned as a three stage system. The first stage retrieves the meteorological data from computer tape or disk files and processes the data through various quality assessment checks. The second stage collects all data available for a 24-hour period (upper air observations, hourly surface weather observations, and data collected as part of an on-site meteorological measurement program) and stores these data in a combined (merged) format. The third stage reads the merged meteorological data and performs the necessary processing to produce a meteorological data file suitable for use by the specified dispersion model.

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SECTION 1
EXECUTIVE SUMMARY

WHY IS THIS PROCESSOR NEEDED?

EPA has recently issued guidance on the use of meteorological data, collected via an on-site measurement program, for regulatory modeling applications (EPA, 1987). The meteorological processors currently available from EPA (Turner and Bender, 1986) do not have the capability of processing user collected on-site meteorological data as directed by the guidance. Therefore, MPRM-1.1 has been designed to construct meteorological data files of upper air, mixing height, surface observations, and on-site data for air pollution dispersion models that are routinely used in regulatory decision making by EPA. Specifically, the processor is designed to accommodate those dispersion models recommended for use in the Guideline on Air Quality Models (Revised) (EPA, 1986).

Since 1986, EPA has provided two processors for organizing meteorological data, RAMMET (Catalano et al., 1987) and MPDA-1.1 (Paumier et al., 1986). RAMMET only processes hourly surface meteorological observations and twice-daily mixing height data in specified formats, CD-144 and TD-9689, respectively, which are available from the National Climatic Data Center (NCDC). (Note: The CD-144 format is equivalent to the TD-1440, Card Image format; namely, the format with 80 characters per record and 10 records per block.) On the other hand, MPDA processes hourly surface observations (CD-144), twice-daily upper air soundings (TD-5600), and additional meteorological data collected via an on-site measurement program. MPDA, however, does not process these on-site data as directed by the newly issued guidance; i.e., the method of processing is vastly different.

At first glance, it might seem reasonable to modify MPDA to accommodate the newly issued guidance. MPDA is a large computer processor that provides processing options not currently accepted for use in regulatory dispersion applications. Revising MPDA for regulatory applications would involve adding processing options (such as use of the twice-daily mixing height interpolation scheme used in RAMMET) and then restricting use of the old processing options if the meteorological data file was intended for regulatory applications. If all one wanted was the ability to process meteorological data for regulatory applications, this modified version of MPDA would be a waste of computer resources.

WHY "THIS" DESIGN?

Since revising MPDA is not feasible, the obvious decision is to develop a new meteorological processor strictly designed for approved regulatory dispersion models. However, recognizing that the list of approved dispersion models is apt to change, and that those changes are likely to call for use of processing methods similar to those currently being tested in MPDA, the new processor is designed similarly to MPDA. Additionally, the new processor is designed to avoid computer conflict problems that have surfaced since MPDA has been installed on several computer systems. It was further decided to develop an input structure that would ultimately support use of a menu data entry system. This would allow construction of the input through a computer-controlled question and answer session, and possibly facilitate the usability of the processor by a variety of users.

WHAT DOES MPRM DO?

MPRM can be envisioned as a three stage processing system. During the first stage, the processor extracts upper air, mixing height, and surface data from the raw data files delivered from NCDC and on-site data from the raw data files developed from the on-site measurement program. The extracted data are processed through a series of quality assessment checks.

As a result, reports of missing and suspect values are generated. During the second stage, the processor combines the available data for each midnight-to-midnight 24-hour period (twice-daily upper air soundings and mixing height data, hourly surface weather observations, and hourly on-site data) and stores these data in a combined (merged) format. During the third and final stage, the processor reads the merged data and develops a meteorological data file for the dispersion model selected by the user.

Extraction and quality assessment (Stage 1 processing)

The goal of this first stage of processing is to:

- Read the on-site and NWS meteorological data files
- Find the data within the time period specified by the user
- Store these data in American Standard Code for Information Interchange (ASCII) data files
- Scan the stored values and report occurrences of missing or suspect values.

MPRM can currently process hourly surface observations in CD-144 format, upper air soundings in TD-5600 format, and mixing height data in TD-9689 format. Persons experienced with RAMMET have a working knowledge of CD-144 data and TD-9689 data. NCDC can provide CD-144 and TD-9689 data on computer magnetic tape or on 5¼-inch diskettes in a format suitable for use in IBM compatible personal computers (PCs) (Heim, 1988). A word of caution regarding the CD-144 format: observations taken every three hours are also available in this format. Because current regulatory dispersion models require an unbroken period of surface weather observations, the user should be certain to specify hourly observations when ordering data from NCDC. MPRM installed on a mainframe computer can process these data either from the computer tape or from mass storage data files. MPRM installed on a PC can process these data either from data files on the hard disk or from 5¼-inch diskettes. We would at least suggest an IBM-AT or equivalent with 640K random access memory (RAM) and a hard disk.

As of 1984, NCDC had converted to new data storage formats for surface observations and upper air soundings, namely, elemental formats TD-3280 and TD-6201, respectively. (For further details regarding these and other developments at NCDC possibly affecting air pollution modeling, refer to Pierce and Turner, 1987). NCDC now converts from these formats to service requests for CD-144 and TD-5600 formatted data. MPRM is designed internally for ready adaptation to these new formats. One, if not the first, upgrade will expand the data formats supported by MPRM to include TD-3280 and TD-6201 formats.

Because there is no standard format for storage of on-site meteorological data, MPRM is designed to process a variety of on-site data formats by having the user define the structure of the input data. The two major restrictions to consider in processing the on-site data are 1) the order in which the data values are presented and 2) the data file must be a standard ASCII data file. In principle, MPRM will be able to process the on-site data as long as the data values for each observation are ordered correctly (date and time, then meteorological values) and the observation can be read using a FORTRAN FORMAT statement. This capability will be discussed in more detail in Section 4.

An additional capability of this first stage is assessing the quality of the data by checking for possible missing or suspect values. Any occurrences of missing or suspect data values are reported before the upper air soundings, mixing height data, surface observations, and on-site data are combined. A discussion of quality assessment during Stage 1 processing is presented in Section 5.

The output files from this first stage of processing can be edited using standard text editors routinely available on computer systems. The only foreseeable problem in editing these data files is that some text editors have a limitation on the size of the file to be edited. This problem is of most concern when the editing is performed on a PC where the text editor is typically limited to the available RAM. For example, because of the RAM limitation, a file consisting of 700 Kb of 1 year of hourly surface observations in CD-144 format could not be edited. A possible solution to this problem is to break the file into parts that can be edited with software designed for this purpose. The modified larger file is recreated by concatenating the smaller files.

Combining data (Stage 2 processing)

The goal of this second stage of processing is to:

- Combine into one file the available on-site and NWS meteorological data files created during Stage 1 processing

- Store the data in a more compact format.

For the specification of the dispersive state of the atmosphere, it is most convenient to consider the physics of the atmosphere on a daily basis, i.e., a 24-hour period. Estimation of the depth of convective mixing is in reality the summation of effects starting with the heating of the surface shortly after sunrise. Thus, the merging of the available data for each 24-hour period is the next logical step in the processing before developing the characterization of the input meteorological data files for the dispersion models.

The merged data are stored in unformatted form because this format provides a more efficient usage of storage than the formatted ASCII data file storage used during the first stage of processing. The ASCII files are convenient for text editors but are no longer needed once the quality assessment and editing are completed.

It is worthwhile to mention here that we recommend retention of the merged data for possible future use beyond the immediate needs. These data can be used to develop data sets for a variety of dispersion models.

Creating a model input file (Stage 3 processing)

The goal of this third stage of processing is to:

- Create a meteorological data file for use with a regulatory dispersion model chosen by the user.

MPRM can generate any one of several output formats to meet the input requirements of the regulatory dispersion model chosen by the user. The RAMMET format has been selected as the default output with default methods for processing wind, temperature, stability category and mixing heights. These methods employ the NWS hourly surface weather observations and NCDC twice-daily mixing heights and duplicate the processing performed by the RAMMET meteorological processor. A complete discussion of processing assumptions is presented in Section 5 and additional output options are presented in Sections 3 and 4.

Since no "modeling" has been performed prior to the third stage of processing, it is anticipated that future changes to the modeling guidelines will have the most impact on this stage of meteorological processing. Acceptance of new algorithms for mixing height estimation, or methods for characterizing the variation of wind speed and wind direction with height, would require that new computer algorithms be supplied within MPRM for use at this stage of processing. Acceptance of a new dispersion model might require changes to the output subroutine within MPRM in order to provide the meteorological data in the format required by the new accepted dispersion model. In consideration of these possibilities, MPRM has a highly modularized design. This allows upgrading of specific parts of the computer code without having to redesign the processor.

RELATIONSHIP OF MPRM TO EPA AIR POLLUTION MODELING GUIDANCE

The data processing methods incorporated into MPRM are intended to implement the recommendations contained in the on-site meteorological program guidance document (EPA, 1987). These recommendations include the determination of Pasquill stability categories from on-site measurements, based on the recommendations in the Guideline on Air Quality Models (Revised). As data processing recommendations are modified, MPRM will be upgraded to reflect the latest guidance. Moreover, any discrepancies that might exist between MPRM and current regulatory guidance should not be construed as guidance, but as errors within the MPRM system.

It is not the purpose of this user's guide to provide a comprehensive summary of all relevant guidance on dispersion modeling for regulatory applications. Other recommendations from the guidance document for conduct of an on-site meteorological measurement program may be relevant to a particular application. For example, the on-site meteorological program guidance document (EPA, 1987) contains recommendations on instrument siting and quality assurance. An important recommendation is that a minimum of 90 percent valid data recovery exist for each variable before a data set can be used for regulatory modeling. The issue of handling missing data values for dispersion modeling is discussed below in more detail. Please note that data substitution cannot be used to reach the 90 percent data recovery rate required by regulatory modeling guidance.

Missing values, the bane of all data sets

When the meteorological conditions are insufficiently declared, a dispersion model will not be able to produce concentration estimates. In the case of dispersion models currently accepted for regulatory applications, the situation is aggravated by the fact that none of the hourly dispersion models can continue processing if the meteorological record is not continuous. The only way to continue processing is to present the dispersion model with an unbroken meteorological record having no missing values.

Substitutions based on other on-site data, if available and deemed to be representative, may provide the best solution for providing an unbroken meteorological record. If the situation is such that only 1 hour's data is missing, it might be practical to use linear interpolation between adjacent hours to estimate the missing meteorological conditions. As the time period of missing values increases, the usefulness as well as the reasonableness of linear interpolation to fill in missing values becomes increasingly more dubious. Rationalizations involving use of monthly mean values from climatological records are sometimes employed. The fact remains that, given the right circumstances, any technique employed for filling in missing values can prove to be inadequate.

A clear consensus has yet to be reached on how best to resolve the dilemma created by a broken meteorological record. A possible solution may involve making substitutions for missing meteorological values for isolated 1-hour periods, and treating longer breaks in the meteorological record within the dispersion model. At the very least, the dispersion models might be modified to process available valid data and to skip (or output a missing value indicator for the concentration estimate) those hours when processing could not continue due to missing values in the meteorological record.

While the guidance document for conduct of on-site meteorological measurement programs contains a recommended hierarchy of data substitution strategies for regulatory applications, the implementation of these recommendations requires expert judgment of "representativeness" of the data substitutions. Yet to be developed is a system of numerical rules having sufficient expertise that we can confidently recommend their use in a universal sense for automatic processing of missing data values.

Since MPRM is constrained to include only processing methods that have been accepted for use in regulatory applications and since we have yet to develop a set of numerical techniques for universal use in handling missing values, MPRM has no automatic method for correcting missing values. If and when techniques are accepted for handling missing values on an automatic basis, they will be incorporated into MPRM, unless of course the resolution is within the dispersion model algorithm.

DOCUMENT OVERVIEW

Section 1 - Explains why this meteorological processor was designed and summarizes its overall structure.

Section 2 - Describes how to install the processor on an IBM compatible PC.

Section 3 - Presents a tutorial of the processor.

Section 4 - Describes the use of several optional processing commands and the commands for processing on-site data.

Section 5 - Summarizes the methods used for the quality assessment checks and the processing the meteorological data in developing estimates of mixing height and stability category.

Section 6 - Summarizes the program structure and installation requirements for use of the processor on IBM and VAX mainframe computers and personal computers.

Section 7 - Describes how to interpret the error messages.

Appendix A - Presents a summary of the keywords used in defining the input to the processor and denotes those that are mandatory and those that are optional.

Appendix B - Describes usage, limitations, and syntax of each keyword.

Appendix C - For each meteorological variable, lists naming conventions used, and default upper and lower range check bounds used in the quality assessment checks.

Appendix D - Provides examples of various reports that can be generated by the processor.

Appendix E - Describes various types of messages that are generated by the processor.

Appendix F - Describes the computer file formats used for the storage of the extracted data.

Glossary - Lists and defines unfamiliar technical terminology used within the guide.

References - Lists material referenced in the guide.

Index - Lists pertinent statements within the guide.

SECTION 2

GETTING STARTED ON A PERSONAL COMPUTER

This section describes what you need to do before you can run MPRM on an IBM compatible PC. The discussion includes a list of the items needed for installation of the MPRM files on the hard disk, the procedure for making a backup copy of MPRM (before installation), and the procedure for the actual installation of those files on the hard disk.

INSTALLATION REQUIREMENTS

You need the following items to install the MPRM files on the hard disk:

- IBM compatible PC with at least 640 Kb of RAM, a hard disk (20 Mb is recommended), and a 5¼-inch disk drive capable of reading 360 Kb diskettes
- Diskettes containing MPRM software
- Blank diskettes (equal to number in MPRM software), formatted or unformatted, for use in making backup copies of the software.

MAKING A BACKUP COPY OF MPRM

The original MPRM software is distributed on double-sided, double-density (360 Kb) 5¼-inch diskettes. The first thing you should do is make a backup copy of the MPRM software. Follow these steps to make the MPRM backup diskettes:

1. Obtain the blank diskettes equal to the number of MPRM diskettes. These can be formatted or unformatted.

2. Assuming that you have a one-floppy-drive system that reads and writes 360 Kb diskettes, place the first MPRM software diskette in drive A: and enter the command "A:"<enter>. (NOTE: <enter> indicates the action of depressing the ENTER or RETURN key.)

3. From the DOS "A" prompt, enter the command:

   ```
   DISKCOPY A:<enter>
   ```

   and respond to DISKCOPY's prompt. The source diskette contents, i.e., MPRM software, are read.

4. After the source diskette is read, DISKCOPY will tell you to put the target (i.e., blank) diskette in the drive. Press ENTER. If the target diskette is unformatted, DISKCOPY will format it. On the other hand, if the target diskette is formatted, DISKCOPY will copy the MPRM software to the target diskette. (WARNING: *IF ANY FILES EXIST ON THE TARGET DISKETTE, THEY WILL BE OVERWRITTEN AND UNRECOVERABLE.*)

5. When DISKCOPY has completed the copying process, it will ask you if you want to copy another diskette. Enter the command "Y"<enter> for yes; continue the process until all diskettes are copied.

If you have any questions, consult your disk operating system (DOS) manual on the DISKCOPY command, particularly if you have a multiple-floppy-drive system or one with a high density drive. However, if you are more familiar with other disk copying procedures, continue to use them.

INSTALLATION OF MPRM

The following steps are used to install the MPRM files on a hard disk designated as drive C:

1. If you have not done so already, create subdirectories UTILITY and MPRM on the hard disk. If you already have a subdirectory for general purpose utilities, use that directory in place of UTILITY.

2. Insert the MPRM diskette labeled "DISK1" into drive A. Using the DOS COPY command, copy the files SQ.COM, UNSQ.COM, and UNSQ.DOC into subdirectory UTILITY.

3. Change to subdirectory MPRM. Enter the command:

   ```
   C:\UTILITY\UNSQ A:*.*<enter>
   ```

4. Insert the diskette labeled "DISK2" into drive A. Enter the command:

   ```
   C:\UTILITY\UNSQ A:*.*<enter>
   ```

The MPRM subdirectory will now contain one data file (of random numbers for use in Stage 3 processing) and two executables (STAGE1N2 and STAGE3). The FORTRAN source code is stored in a compressed format on the MPRM software diskettes labeled "DISK3" and "DISK4." The source code is not needed except to make modifications to the processor. In such cases, a FORTRAN compiler will be needed. A discussion on which files are needed to create the executable code from the source code is presented in Section 6. The diskette labeled "DISK5" contains the run streams discussed in Sections 3 and 4 along with several small data sets.

SECTION 3
TUTORIAL

INTRODUCTION

This section provides a demonstration of the three processing stages outlined in Section 1. Examples to illustrate the input and the output associated with each of the three stages are presented.

For discussion purposes, the activities of extracting data from the raw data files and processing these data through a series of quality assessment checks are labeled as Stage 1. Data extraction is a one-time activity, only repeated when additional data are required; whereas quality assessment checks may be performed several times on the same file. These quality assessment checks allow suspect data values to be located within the data. Once it is determined how such suspect values are to be treated, a text editor can be used to inspect and adjust these values. (NOTE: Such alterations should only be done on the extracted data files, not to the original raw data files. The original data files should never be altered, as they represent the original archive as delivered.)

Whenever alterations are made to the extracted data file, the data should be reprocessed through the Stage 1 quality assessment checks. This provides a final listing of data, and may call attention to new problems that need to be fixed. When as many of the suspect and missing values as possible have been eliminated, Stage 2 processing (merging) can begin.

At the completion of Stage 2 processing, the data have been combined (merged) into one data file. Stage 3 processing can then be used to construct the data files needed to accommodate dispersion modeling.

IMPORTANT NOTE FOR DEVELOPMENT OF METEOROLOGICAL DATA FILES FOR USE WITH HOURLY DISPERSION MODELS

Because MPRM has no provisions to automatically eliminate missing values and because the current regulatory models for hourly dispersion model simulations are inoperable when meteorological data are missing, all missing values will have to be manually replaced during Stage 1 processing.

The three stages of processing provided for within MPRM are summarized in Figure 3-1. As shown in the figure, there are two executables providing access to the three stages of processing. The first executable, STAGE1N2.EXE, supports Stage 1 and Stage 2 processing. As discussed in Section 1, Stages 1 and 2 processing are concerned with the extraction of the data from the raw data files, the quality assessment checks of these data, and the combination of these data into a single data file for subsequent processing. The second executable, STAGE3.EXE, supports Stage 3 processing, which processes the available meteorological data for use by a particular dispersion model.

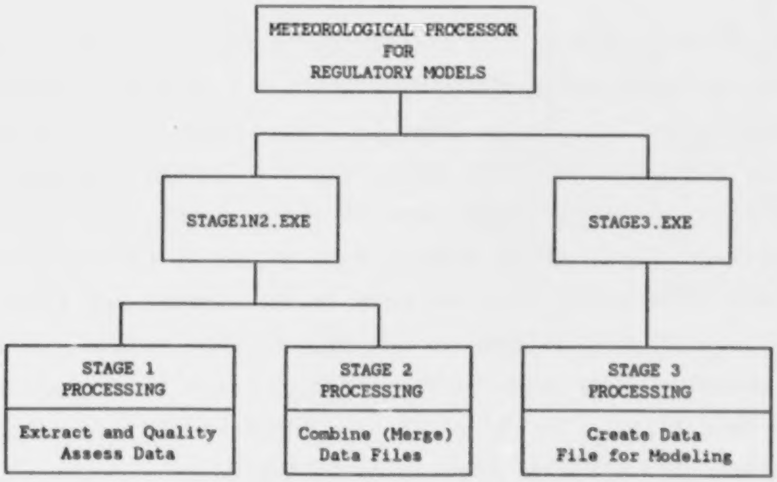

METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS
STAGE1N2.EXE
STAGE3.EXE
STAGE 1 PROCESSING
Extract and Quality Assess Data
STAGE 2 PROCESSING
Combine (Merge) Data Files
STAGE 3 PROCESSING
Create Data File for Modeling

Figure 3-1. Overview of processing stages within MPRM.

MPRM Input Syntax

We refer to the collection of all input necessary to run the MPRM processor as the input run stream or simply run stream. The run stream consists of several 80-character images, each of which begins with a 2-character group, called a pathway identification, followed by a 3-character group, called a keyword. The keywords define the general process to be defined, while the pathway identifications define the overall processing goals.

> *Each input run stream can be thought of as a sequence of 80-character images. Each image consists of two or more fields. The fields presented within the 80-character image are considered FREE format; that is, proper interpretation of a field is not dependent on column position. However, the fields must be separated by commas or spaces.*

The logic within the processor, and hence the input to the processor, can be functionally divided into six major areas. These areas are called pathways and derive their names (pathwayID) from the functions performed. Each pathway has one of the following two-letter acronyms:

- JB - processes that affect or pertain to the entire job
- UA - processing NWS upper air data and NCDC mixing height data
- SF - processing NWS hourly surface weather observations
- OS - processing user supplied on-site meteorological data
- MR - process of combining (merging) all available meteorological data
- MP - processing for a particular dispersion model.

Input images in the run stream are always directed to one of the pathways listed.

There is a certain structure to the input. Once familiar with the "language," the input images will almost read in plain language. A summary of the input possibilities is presented in two appendices. Appendix A lists and defines the mandatory and optional input for each process and Appendix B discusses in more detail how to define the fields associated with each input image. Together these two appendices enable the user to construct customized run streams.

One of the first and obvious questions that arises is, what information is needed and how is this information conveyed to the MPRM processor? To answer this question, one first must define what processing is to be accomplished. Basically, we have three processing options to choose from, corresponding to the three stages of processing:

1. To extract and/or quality assess data.
2. To combine (merge) data files that have been quality assessed.
3. To create an input meteorological data file for a dispersion model.

For any run stream to be complete, we must at the very least define an error/message file, which is done using a JB ERR input. Hence, every run stream has input directed towards the JB pathway. Whether we have input directed to one or more of the other pathways depends on the data to be processed and the processing to be accomplished. Appendix A summarizes what input is mandatory and what input is optional for each pathway as a function of the processing to be accomplished.

Processing on a PC

On a PC, the default input is the keyboard (UNIT 5) and the default output is the screen (UNIT 6). For MPRM, the default input is used for reading the input run stream, and the default output is used for writing the general report information summarizing the results of the processing.

On a PC, the output directed to UNIT 6 can be redirected to a file using a DOS command. Suppose the run stream for Stage 1 processing is stored in a file entitled "STAGE1.INP", and suppose that we wish the general report information to be written to a file entitled "REPORT.LIS".

Shown below is an example of how one might initiate Stage 1 processing on a PC

```
STAGE1N2 <STAGE1.INP  >REPORT.LIS
```

This statement directs the run stream to be read from the file STAGE1.INP and the general report output to be written to the file REPORT.LIS. In this example, the input file (STAGE1.INP) and the executable file (STAGE1N2.EXE) are assumed to reside in the current directory, and the output file (REPORT.LIS) will be placed in the current directory. Note, it is not necessary to include the .EXE suffix to invoke executables.

Overview

The tutorial discussion begins with a Stage 1 example involving the extraction and processing of 4 days of NWS hourly surface observations and 6 days of twice-daily mixing heights. The data are then combined (Stage 2) into one data file for final processing. Lastly a Stage 3 example generates an output file identical to the RAMMET processor. RAMMET output can be used with dispersion models BLP, RAM, ISC (short term), MPTER, CRSTER, and COMPLEX1.

We suggest that if the MPRM system has not yet been installed, that the procedures outlined in Section 2 be accomplished. Then the examples can be executed following the discussion in the tutorial.

We do not recommend providing the input directly from the keyboard. The run streams are sufficiently long and complex to preclude direct input from a keyboard. We strongly suggest use of a text editor to create the necessary run streams in small data files. These files must be composed of standard ASCII characters. Some text editors differentiate between document files and non-document files, with the document files being composed of special control characters. For such editors, select the non-document mode of editing. Then follow the example provided above for providing the run streams to the processor.

EXTRACT AND QUALITY ASSESS DATA (STAGE 1)

Description of example input for Stage 1

As only several days of data are involved and as the purpose of this tutorial is to provide an overview of the operation of the processor, the extraction and quality assessment of both the surface and mixing height data will be performed in one step. Presented in Figure 3-2 is an annotated sample run stream for performing these activities. This run stream is file EXAMPLE1.INP on DISK5. Note, in a real application employing larger data files, it might be more practical and manageable to extract and quality assess the data for each pathway separately. Example run streams for such processing are presented in Section 4.

The input images to the processor have a structure, which when understood, facilitates construction of customized run streams. The three-character keywords are, for the most part, abbreviations of the actions that this input should invoke.

2-character pathway identifications (PathwayID)
3-character action identifications (Keyword)

JB STA	Starts general definitions (JB-pathway)
JB ERR DISK ERRBRF.LIS	Defines file name for error/message file
JB FIN	Terminates JB-pathway data
UA STA	Starts upper air and mixing height data (UA-pathway)
UA IN2 USER RAMZI.DAT (A5,3I2,1X,I5,13X,I5) 93815	Defines mixing height input data
UA IQA DISK IQAZIBRF.DAT	Defines output location of extracted mixing height data
UA OQA DISK OQAZIBRF.DAT	Defines output location of mixing height data following quality assessment checks
UA LOC 93815 84.68W 39.07N +0	Defines location of mixing height data
UA EXT 63 12 31 64 01 05	Defines time period to extract mixing height data
UA FIN	Terminates UA-pathway data
SF STA	Starts hourly surface data (SF-pathway)
SF IN2 DISK RAMSFC.DAT CD144FB 93814	Defines surface input data
SF IQA DISK IQASFBRF.DAT	Defines output location of extracted surface data
SF OQA DISK OQASFBRF.DAT	Defines output location of surface data following quality assessment checks
SF LOC 93814 84.00W 39.00N 0	Defines location of surface data
SF EXT 64 01 01 64 01 04	Defines time period to extract surface data
SF FIN	Terminates SF-pathway data

Figure 3-2. Run stream for extraction and quality assessment of mixing height data for a 6-day period and surface observations for a 4-day period.

Consider the first two lines of input shown in Figure 3-2.

```
┌──── 2-character pathway identifications (PathwayID)
│
│   ┌ 3-character action identifications (Keyword)
│   │
JB STA

JB ERR DISK ERRBRF.LIS
```

The STA is derived from "start". The JB STA input defines the beginning (or start) of those inputs that have general meaning to the processing job to be defined. The ERR input is derived from "error". The JB ERR input defines the file name where the error, warning, informational, and quality assessment messages produced by the processor are written.

The third line (JB FIN), terminates the general job information. The fourth line (UA STA), starts defining the parameters and actions to be performed on the upper air and mixing height data. This is referred to as the UA-pathway. The fifth line, starting with UA IN2, defines the file storage medium, file name, data format and station identification.

The fields following the keywords can vary somewhat depending on the pathway. For instance, compare the usage of the keyword IN2, as shown in the example in Figure 3-2, on the two pathways UA and SF.

```
┌──── 2-character PathwayID: UA = NWS upper air/mixing height
│                            SF = NWS hourly surface
│
│   ┌ 3-character Keyword: IN2 = Original (raw) input data
│   │
UA IN2 USER RAMZI.DAT (A5,3I2,1X,I5,13X,I5) 93815

SF IN2 DISK RAMSFC.DAT CD144FB 93814
       └───────────────────────┬───────────────────────┘
                     Fields following keyword
```

In this example, the mixing height data, stored in a file named RAMZI.DAT, is not in the traditional format (TD-9689) as delivered from

NCDC. To alert the processor that the format is being provided, the data field just after the keyword IN2 was set to USER. To inform the processor of the format, the FORTRAN FORMAT statement (A5,3I2,1X,I5,13X,I5) has been provided. The last item in the UA IN2 input is 93815, which is the station number for the NWS observation site at the Dayton, Ohio airport. The hourly surface observations are in NCDC format CD-144. This information is conveyed to the processor by the format number CD144FB and the use of DISK in the SF IN2 input.

When purchased from NCDC, the surface data are available in a variety of storage formats. As discussed earlier, for now, MPRM can only process the CD-144 format. In the near future, MPRM will be upgraded to allow for processing of the newer TD-3280 format; however, there are still several formats available. For instance, NCDC provides the 1440 data on computer tape in fixed block (FB) in either ASCII or EBCDIC, or on DOS formatted diskettes in ASCII characters. The MPRM can process any of the 1440 (CD-144) formats. As explained in Appendices A and B, if the storage medium is computer tape, replace DISK with TAPE on the IN2 input, specify fixed-blocking (FB), and specify whether ASCII or EBCDIC.

The file name syntax here and in subsequent examples follows the PC naming conventions. It has further been assumed that all the files, including the executables, reside in the same directory. The VAX conventions use square brackets to enclose the directory information that is necessary for complete specification of the filename. For instance in the above example, the file named ERRBRF.LIS might look like [MPRM.DOC]ERRBRF.LIS, on a VAX system. Whether working with the MPRM on a VAX or a PC, we recommend specification of the complete file pathnames.

As noted in Appendix A, whenever data are extracted, the location must be defined (using a LOC input), and the start and stop dates for the data to be accepted must be defined (using an EXT input).

The LOC input defines the station identification number, the latitude and longitude, and the number of hours difference between local standard time (LST) and Greenwich mean time (GMT). The latitude and longitude are given in decimal degrees. Upper air soundings are given in Greenwich Mean Time and the +5 is the correction needed to convert these times to Local Standard Time (LST) for Dayton, Ohio. This correction factor has to be given in the input because the time zones follow political boundaries rather than lines of longitude.

The EXT input defines the starting year, month, and day, and the ending year, month, and day of the period to be extracted and stored in the data files named in the UA IQA and SF IQA images. The sequence year, month, and day must be observed in defining extraction dates. The year may be expressed either by all four digits or by the last two digits.

For processing the UA data through quality assessment, the input data file is defined by the IQA image. The file defined by the Output-from-Quality-Assessment (OQA) input image is used to store the data read from the IQA file as it is processed through the quality assessment checks. The format of the data written to the OQA file is identical to that for the IQA file.

There may be a question: Why have the OQA file if it is essentially a copy of that given in the IQA file? Answer: Primarily for future accommodation of automatic replacement procedures for missing values. In the future, such procedures may be established. By having the two files (IQA and OQA), the MPRM system has a logical design for assessing the data, reporting suspect or missing values, and storing the new values (replacing missing values). Altered values can then be examined for consistency and reasonableness.

At the completion of input to each pathway, a FIN image must be provided. For instance, the UA FIN terminates the definition of the UA-pathway input images.

It is not the intent of this tutorial to fully explain each of the items shown in Figure 3-2. Hopefully, with actual experience and with the descriptions provided here and within the appendices, the input images will begin to make sense. The options available in the input are summarized in Appendix A, where the keywords available to each pathway are defined along with whether the input is mandatory or optional. Appendix B provides detailed descriptions of the data fields following the keywords and can be used to decipher those shown in Figure 3-2.

Summary of Stage 1 Output

The MPRM produces three types of output files as outlined in Figure 3-3.

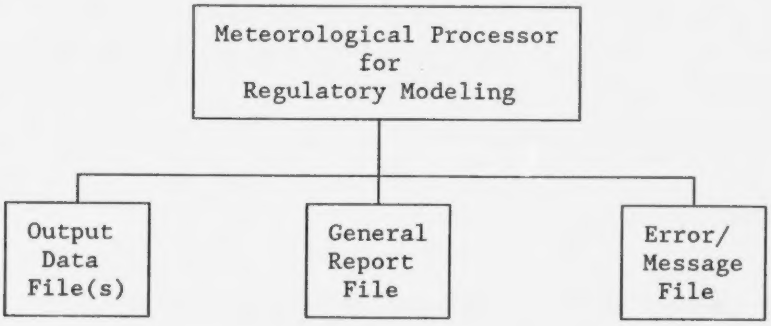


Figure 3-3. Overview of MPRM output.

Four output data files are produced, in the example shown in Figure 3-2. Two are from processing the mixing height data - the raw extracted data file, defined by the UA IQA input, and the quality assessed data file, defined by the UA OQA input. Two similar output data files are produced associated with the processing of the hourly surface weather observations.

The general output report summarizes the processing results and is typically only several pages long.

Within the error/message file reside all the messages generated during processing. Appendix E summarizes the various messages that can be generated by the processor. There are nearly 100 different messages possible. Understandably, the error/message file may be rather long. It is not advisable to print this file, unless it is necessary. The user should view the contents using a general purpose text editor. A discussion of the structure and content of the error messages written to the error/message file is provided in Section 7. Also within Section 7 is provided a discussion of how the general report is altered when errors are encountered.

The output files and reports will not be discussed in detail within this tutorial. The general report generated by this Stage 1 example is the first example report shown in Appendix D. Basically, the report lists the input and output files, a table summarizing the kinds and frequency of occurrences of the messages generated, and a table (or tables, if more than one data pathway is processed) summarizing the results of the quality assessment of the data. A more complete discussion of the content of the general report appears in Section 4.

COMBINE (MERGE) DATA FILES (STAGE 2)

At the completion of Stage 1 processing, there exist from one to three data files. The three possible files are:

- NWS upper air observations combined with NCDC twice-daily mixing height values (UA-pathway data)
- NWS hourly surface weather observations (SF-pathway data)
- User supplied on-site meteorological data (OS-pathway data).

The data files resulting from Stage 1 processing are standard ASCII data. This means that routine text editors can be used to view the data, or to fill in values for missing time periods of data. This is all quite convenient but it is also quite wasteful of computer storage. A more compact and efficient storage format is unformatted. FORTRAN programs can process unformatted data faster than they can ASCII data. The two goals of Stage 2 processing are to combine and organize the data (so the user knows what data are available each day) and to convert to unformatted storage.

Presented in Figure 3-4 is an annotated run stream performing these activities. Comparison of the two run streams shown in Figures 3-2 and 3-4 reveals that the only new items in Figure 3-4 are those specific to the OS-pathway and the MR-pathway. Basically, this run stream identifies the data files to be merged (OQA input images), the filename for the merged data file (MR OUT image), the location of interest for dispersion modeling (OS LOC image), and the time period to be merged (MR EXT image).

The two data files OQAZIBRF.DAT and OQASFBRF.DAT will be combined (merged) into one data file named MERGEBRF.DAT for the period from January 1, 1964 through and including January 4, 1964.

When creating a merged data set, it is required that the OS LOC input be provided. This longitude and latitude will be stored in the header of the MR OUT data file. It is unlikely that the sites where the UA, SF, and OS data were collected are collocated. It may be that the location of interest for the dispersion modeling is not located at any one of the locations where the UA, SF, and OS data were collected. The longitude and latitude given in the OS LOC input, when the data are merged, is interpreted as the location of interest in the dispersion modeling.

The general report created by the example shown in Figure 3-4 is the second example report shown in Appendix D. This report is quite similar to that generated by the example shown in Figure 3-2.

2-character pathway identifications (PathwayID)
3-character action identifications (Keyword)

JB STA	Starts general definitions (JB-pathway)
JB ERR DISK MRBRFERR.LIS	Defines file name for error/message file
JB FIN	Terminates JB-pathway data
UA STA	Starts upper air and mixing height data (UA-pathway)
UA OQA DISK OQAZIBRF.DAT	Defines output location of mixing height data following quality assessment checks
UA FIN	Terminates UA-pathway data
SF STA	Starts hourly surface data (SF-pathway)
SF OQA DISK OQASFBRF.DAT	Defines output location of surface data following quality assessment checks
SF FIN	Terminates SF-pathway data
OS STA	Starts hourly on-site data (OS-pathway)
OS LOC 9381464 84.68W 39.07N 0	Defines location associated with on-site data and/or dispersion modeling
OS FIN	Terminates OS-pathway data
MR STA	Starts merged data (MR-pathway)
MR OUT DISK MERGEBRF.DAT	Defines output location for merged data
MR EXT 64 01 01 64 01 04	Defines time period for combined (merged) data
MR FIN	Terminates MR-pathway

Figure 3-4. Run stream for combining (merging) data files of mixing height data for a 6-day period and hourly surface observations for a 4-day period.

PROCESS DATA FOR A RAMMET TYPE DISPERSION MODEL (STAGE 3)

The goal of Stage 3 processing is to process the merged data and to produce an output file for use by a particular dispersion model. In default mode, Stage 3 processing produces an output file in the RAMMET format. This format accommodates several of the hourly models currently approved for routine use in regulatory decision making. Presented in Figure 3-5 is an annotated run stream for performing the Stage 3 processing.

As a minimum, Stage 3 processing requires the file name of the input (merged) data file and the output file name for use by the dispersion

```
┌─────────────── 2-character pathway identifications (PathwayID)
│ ┌─────────────── 3-character action identifications (Keyword)
JB STA ──────────────────────────────────── Starts general definitions
                                            (JB-pathway)
JB ERR DISK ST3AERR.LIS ─────────────────── Defines file name for
                                            error/message file
JB FIN ──────────────────────────────────── Terminates JB-pathway data
MP STA ──────────────────────────────────── Starts MP-pathway data
MP MET DISK MERGEBRF.DAT  5 ─────────────── Defines merged input
                                            meteorological data file
MP MMP DISK STAGE3A.DAT CRSTER ──────────── Defines output file for
                                            use by dispersion model
MP EXT 64 1 1 64 1 4 ────────────────────── Defines period of data to
                                            be processed
MP LST ──────────────────────────────────── (Optional) Turns on listing
                                            of dispersion model
                                            meteorological data to
                                            general report file
MP TRA ──────────────────────────────────── (Optional) Turns on
                                            detailed listing of
                                            messages to error/message
                                            file
MP FIN ──────────────────────────────────── Terminates MP-pathway data
```

Figure 3-5. Run stream for developing a meteorological data file in RAMMET format from a merged data file of mixing height data for a 6-day period and surface observations for a 4-day period.

model. There are various methodologies for generating the output meteorological data file. The RAMMET format has been selected as the default. This is an unformatted file containing a header record and one record for each 24-hour period. The default selections for processing wind, temperature, stability category, and mixing height employ the NWS hourly surface weather observations and the NCDC twice-daily mixing height values. A full discussion of the processing assumptions is given in Section 5. In essence, processing with the default selections duplicates that performed by the RAMMET meteorological processor.

Two of the new input records shown in Figure 3-5 are MP MET and MP MMP. They are used to identify the file name of combined (merged) input meteorological data (MP MET) and the file name for storage of the output meteorological data (MP MMP) for use by a particular dispersion model. The number 5, given after the file name in the MP MET input, is the number of hours to be added to local standard time (LST) to convert LST to Greenwich Mean Time (GMT).

Included as an option within the MP MMP input is the ability to define the dispersion model anticipated to be accessing the output meteorological data file. Appendix F provides specific details regarding the various output formats. If no dispersion model name is included in the MP MMP input image, the default selection is CRSTER. The available choices are:

BLP, RAM, ISCST, MPTER, CRSTER, COMPLEX1	Selection of these models results in the output file having a RAMMET storage format. This format has 24 hours of data in each record.
CALINE-3	This selection results in an output file format unique to CALINE-3. This format has 1 hour of data in each record.

RTDM	This selection results in an output file format unique to RTDM. This format has 1 hour of data in each record.
VALLEY, ISCLT, CDM16	This selection results in an output file containing the joint frequency function of the meteorological conditions. Sixteen wind sectors are used in developing the frequency function, with the first 22.5° sector centered on winds from the North.
CDM36	This selection results in an output file containing the joint frequency function of the meteorological conditions. Thirty-six wind sectors are used in developing the frequency function, with the first 10° sector centered on winds from the North.

The CDM-2.0 dispersion model can process meteorological frequency function data (often referred to as STabiltiy ARray data, STAR), constructed using either 16 or 36 wind direction sectors. To provide for this flexibility, we have used CDM16 and CDM36 to identify whether 16 or 36 wind direction sectors are desired in constructing the STAR data. STAR output for ISCLT and VALLEY models use the six stability categories: A, B, C, D, E, F. STAR output for CDM use the six stability categories A, B, C, D-day, D-night, E-F.

Stage 3 Output Options

In the example shown in Figure 3-5, there are two optional input items. One of these activates the listing of the generated meteorological data to the general report file and the other enhances the detail provided in the Stage 3 processing messages. The extra output produced by these two options are of little concern in this example, since there are only 4 days of output. If a longer period of record were involved, say a 1-year period, one might question the wisdom of employing these options. As will be seen in the general report for this example, the listing of the RAMMET type meteorological data requires one page of output for every 3 days listed. This would result in 122 pages of output in listing 1 year's output of RAMMET data. If output for RTDM or CALINE-3 was being generated, the list option would require one page for each 2 days listed (or 183 pages for 1 year).

The MP TRA input image currently has meaning only with the determination of the Pasquill stability category. As is described in Section 5, there are five different methodologies available for specifying the stability category: one is equivalent to the RAMMET processor and employs only NWS data, the other four employ on-site data. Since all of the on-site data methods are acceptable, MPRM searches for an alternate on-site method if the primary method is incapable of working for a given hour due to lack of data. The TRA option reports the results of such searches whenever they occur. If these searches were to occur frequently, the error/message file might well become quite large. Indiscriminate use of the TRA option is not recommended. A better use of the TRA option would be to process short periods of record that are known to contain frequent periods of missing data. The MP EXT input can be used to control the dates processed. In this manner, the search results can be reviewed in a manageable fashion. Obviously, if an alternate method for specifying the stability category is employed too often, it may invalidate the use of the data for certain regulatory actions. (Refer to the discussion on missing data in Section 1 for further details.)

A Closer Look at the General Report Content

The Stage 3 general report is structured somewhat differently than that generated during Stages 1 and 2. With the MP LST input, the first page of the general report (shown in Figure 3-6) provides the header information written to the beginning of the output file (defined within the MMP input). Then follows the listing of the generated meteorological data values. This listing continues on as many succeeding pages as necessary to complete the listing (Figure 3-6). For the example shown in Figure 3-5, the listing is completed in two pages.

Following the listing of the generated values, the general report lists the files accessed, and the processing selections as determined from the run stream data (Figures 3-7 and 3-8). It is beyond the scope of this tutorial to discuss the various options available for specifying the wind speed, wind direction, stability category, and mixing height. This is discussed in Section 4. (Table 4-1 provides a quick summary of the processing options available.) Within item 6 of the general report are listed the file names of the output files. For the example shown, the generated meteorological data file, in RAMMET format, was stored in STAGE3A.DAT.

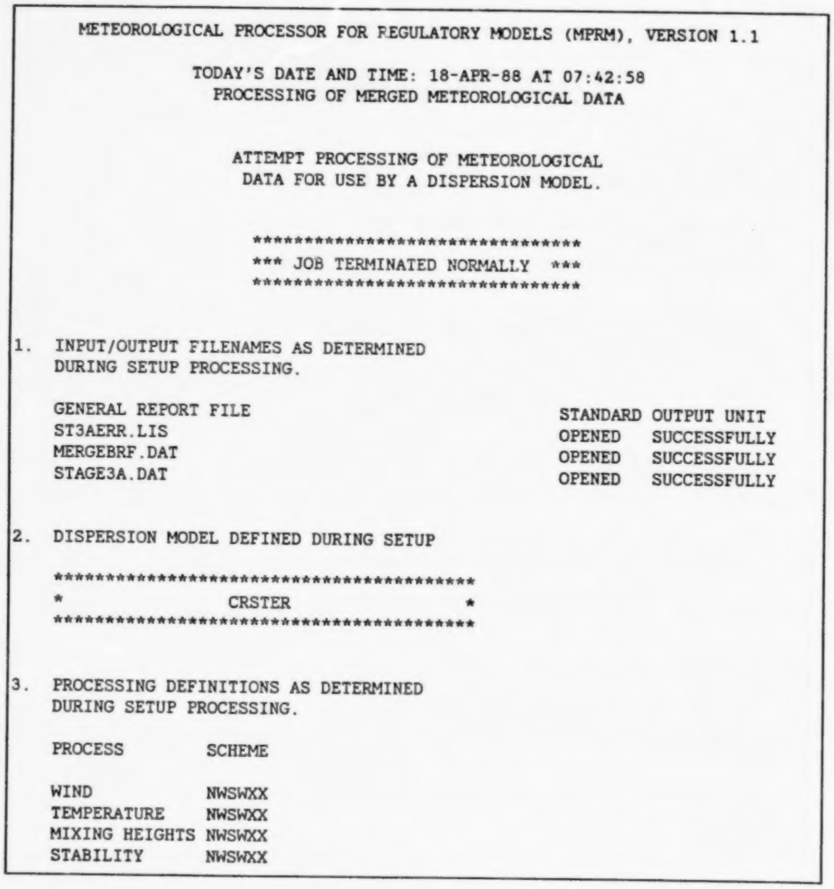
The next two pages of the general report, shown in Figures 3-9 and 3-10, summarize the job termination status, the status of files referenced, the dispersion model selected (CRSTER is default), and the processing selections for generating the output meteorological file. In item 3 of the report, NWSWXX indicates that the meteorological variable (process) will be determined using NCDC mixing heights and NWS hourly weather observations. This is exactly what the RAMMET processor does.

The processor assigns a default value of 10 m as the measurement height of wind and turbulence data (item 4 in Figure 3-8). Within the processor this is referred to as the anemometer height, ANEHGT. When

```
        METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                   TODAY'S DATE AND TIME: 18-APR-88 AT 07:42:56
                    PROCESSING OF MERGED METEOROLOGICAL DATA


*** HEADER ON OUTPUT MP-DATA FILE:       93814        64     93815        64


YEAR= 64 MONTH=  1 DAY=  1 JULIAN DAY=   1 SUNRISE=   8.051 SUNSET=  17.353
PGSTAB=   4     4     4     4     4     4     4     4     4     4     4     4
SPEED=  4.1   6.7   6.7   5.7   5.7   6.2   9.3   7.7   6.2   4.6   5.7   6.2
TEMP=   268.  268.  268.  268.  269.  269.  270.  270.  269.  269.  270.  270.
FLWVEC= 210.  230.  220.  220.  210.  220.  230.  230.  190.  150.  160.  180.
RANFLW= 211.  228.  224.  223.  213.  222.  235.  233.  187.  151.  164.  176.
RURAL=  511.  483.  456.  429.  401.  374.  347.  319.  292.  264.  237.  210.
URBAN=  511.  483.  456.  429.  401.  374.  347.  319.  292.  264.  237.  210.

PGSTAB=   4     4     4     4     4     5     5     4     4     4     4     4
SPEED=  4.6   3.6   5.7   6.2   4.6   3.6   4.1   5.7   8.2   7.2   6.2   7.7
                                         .
                                         .
                                         .

YEAR= 64 MONTH=  1 DAY=  3 JULIAN DAY=   3 SUNRISE=   8.054 SUNSET=  17.379
PGSTAB=   4     4     4     4     4     4     4     4     4     4     4     4
SPEED=  8.8   8.8   8.8   7.7   6.7   6.2   6.2   6.2   7.2   7.7   7.2   7.7
TEMP=   278.  279.  279.  279.  279.  279.  279.  279.  279.  279.  280.  281.
FLWVEC=  40.   40.   40.   40.   30.   30.   30.   30.   40.   40.   40.   40.
RANFLW=  40.   36.   44.   40.   27.   29.   26.   29.   38.   44.   42.   38.
RURAL=  507.  497.  487.  477.  467.  457.  447.  437.  426.  416.  406.  396.
URBAN=  507.  497.  487.  477.  467.  457.  447.  437.  426.  416.  406.  396.

PGSTAB=   4     4     4     4     4     4     5     4     4     4     4     5
SPEED=  6.7   7.2   7.2   6.7   4.6   6.2   5.1   5.7   4.1   8.8   7.2   5.1
TEMP=   281.  282.  283.  283.  282.  281.  279.  279.  278.  278.  278.  276.
FLWVEC=  50.   60.   50.   60.   60.   90.  100.  110.   90.  110.  110.  100.
RANFLW=  51.   62.   47.   60.   59.   91.   97.  108.   87.  109.  111.   97.
RURAL=  386.  376.  376.  376.  376.  398.  434.  469.  505.  540.  576.  611.
URBAN=  386.  376.  376.  376.  376.  398.  555.  469.  505.  540.  576. 1108.
```

Figure 3-6. Excerpts from the first page of general report, for example where a RAMMET type output file is generated.

processing in default mode, there are no modeling decisions that employ ANEHGT. Hence, the value assigned to ANEHGT is of little significance. The value assigned to ANEHGT becomes of significance for those processing options employing use of on-site data, which will be discussed in Section 4. Item 5 of the report summarizes the location information determined from the header records within the merged data file. Currently the longitude and latitude values given for the on-site data are used in processing. The only processing decisions that require longitude and latitude are in the determination of the position of the sun. The

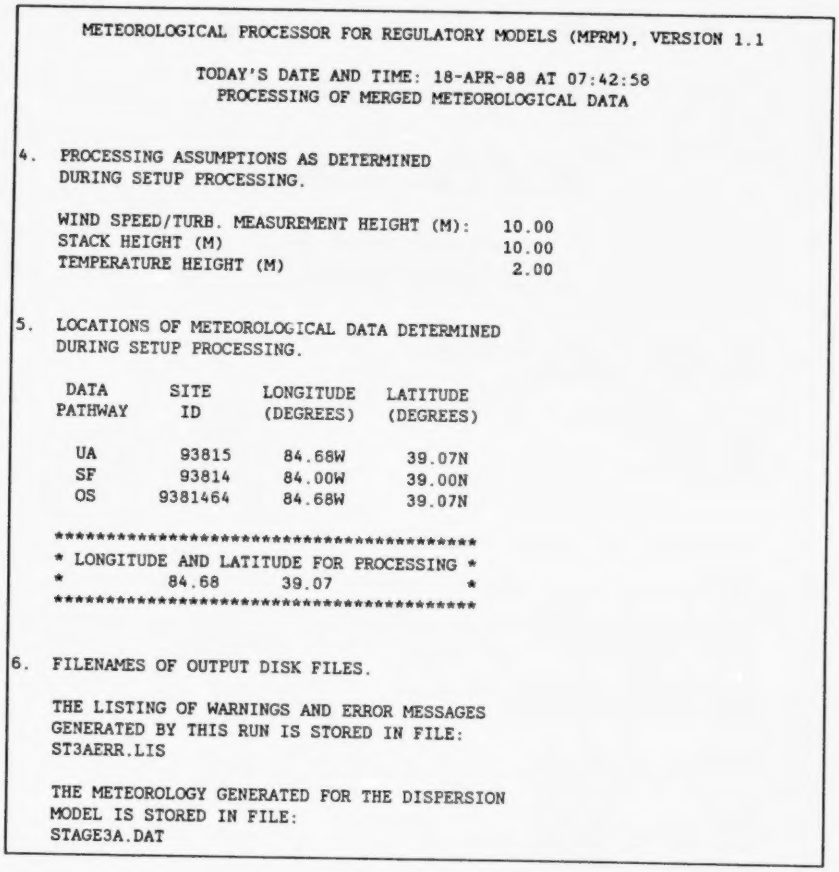


```
        METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                     TODAY'S DATE AND TIME: 18-APR-88 AT 07:42:58
                      PROCESSING OF MERGED METEOROLOGICAL DATA


                        ATTEMPT PROCESSING OF METEOROLOGICAL
                         DATA FOR USE BY A DISPERSION MODEL.


                         **********************************
                         *** JOB TERMINATED NORMALLY  ***
                         **********************************


1.  INPUT/OUTPUT FILENAMES AS DETERMINED
    DURING SETUP PROCESSING.

    GENERAL REPORT FILE                                   STANDARD OUTPUT UNIT
    ST3AERR.LIS                                           OPENED   SUCCESSFULLY
    MERGEBRF.DAT                                          OPENED   SUCCESSFULLY
    STAGE3A.DAT                                           OPENED   SUCCESSFULLY


2.  DISPERSION MODEL DEFINED DURING SETUP

    ********************************************
    *                 CRSTER                   *
    ********************************************


3.  PROCESSING DEFINITIONS AS DETERMINED
    DURING SETUP PROCESSING.

    PROCESS          SCHEME

    WIND             NWSWXX
    TEMPERATURE      NWSWXX
    MIXING HEIGHTS   NWSWXX
    STABILITY        NWSWXX
```

Figure 3-7. Third page of general report, for example where a RAMMET type output file is generated.

elevation angle of the sun with respect to the horizon is used to determine sunrise, sunset, and insolation class, all of which are significant when processing stability category using the default scheme (NWSWXX). The sixth and final item is a listing of the file names used for the output files containing the error messages and the generated meteorological data.

Since missing values are an anathema to most of the dispersion models routinely employed in regulatory analyses, a table is presented indicating the number (if any) of hours specified with missing values, see Figure 3-9.



```
        METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                  TODAY'S DATE AND TIME: 18-APR-88 AT 07:42:58
                   PROCESSING OF MERGED METEOROLOGICAL DATA

4.  PROCESSING ASSUMPTIONS AS DETERMINED
    DURING SETUP PROCESSING.

    WIND SPEED/TURB. MEASUREMENT HEIGHT (M):   10.00
    STACK HEIGHT (M)                           10.00
    TEMPERATURE HEIGHT (M)                      2.00

5.  LOCATIONS OF METEOROLOGICAL DATA DETERMINED
    DURING SETUP PROCESSING.

     DATA      SITE     LONGITUDE   LATITUDE
    PATHWAY     ID      (DEGREES)   (DEGREES)

      UA       93815      84.68W      39.07N
      SF       93814      84.00W      39.00N
      OS     9381464      84.68W      39.07N

    ******************************************
    * LONGITUDE AND LATITUDE FOR PROCESSING *
    *          84.68      39.07             *
    ******************************************

6.  FILENAMES OF OUTPUT DISK FILES.

    THE LISTING OF WARNINGS AND ERROR MESSAGES
    GENERATED BY THIS RUN IS STORED IN FILE:
    ST3AERR.LIS

    THE METEOROLOGY GENERATED FOR THE DISPERSION
    MODEL IS STORED IN FILE:
    STAGE3A.DAT
```

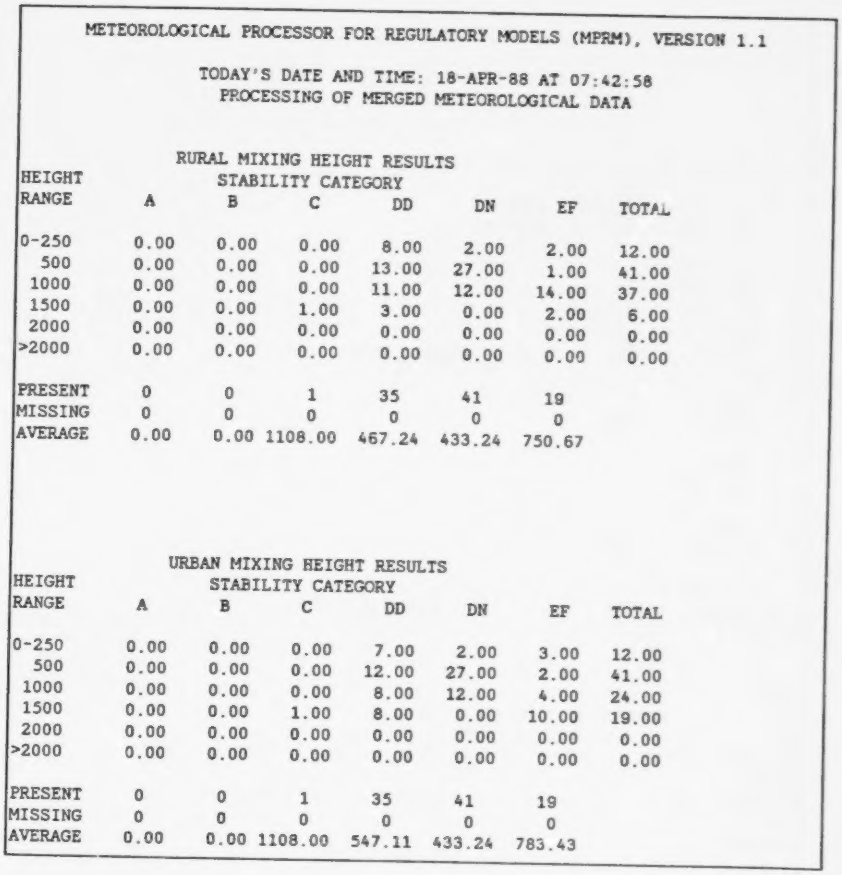
Figure 3-8. Fourth page of general report, for example where a RAMMET type output file is generated.

For the 96 hours of data processed in this example, there were no missing values. Next is presented a table summarizing the wind speed values. Presented in the table are the frequency of occurrences and the harmonic average value (m/s) for six wind speed ranges. The ranges are 0-3, 4-6, 7-10, 11-16, 17-21, and >21 kts. In the example presented, there were nine cases with wind speeds greater than 16 and less than (or equal to) 21 kts, and the harmonic average wind speed for the nine cases was 9.07 m/s. Also presented is a table summarizing the methods used in specifying the stability category.

```
     METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                   TODAY'S DATE AND TIME: 18-APR-88 AT 07:42:58
                     PROCESSING OF MERGED METEOROLOGICAL DATA


   SUMMARY OF DATA PROCESSING RESULTS

                NUMBER   NUMBER
   VARIABLE     PRESENT  MISSING

   STABILITY
   CATEGORY      96         0

   WIND
   SPEED         96         0    NUMBER CALMS:      0

   WIND
   DIREC.        96         0

   RURAL
   MIX HGT.      96         0

   URBAN
   MIX HGT.      96         0

   AMBIENT
   TEMPER.       96         0    AVERAGE (C)  0.93



               SUMMARY OF WIND SPEED RESULTS
                     WIND SPEED CLASS
              1       2       3       4       5       6
NUMBER
PRESENT     0.00    9.00   21.00   57.00    9.00    0.00

AVERAGE
SPEED       0.00    3.04    4.30    6.67    9.07    0.00


              SUMMARY OF STABILITY COMPUTATIONS
    NWSWXX      ONSITE      SESITE      SASITE      WNDWXX
        96           0           0           0           0
```

Figure 3-9. Fifth page of general report, for example where a RAMMET type output file is generated.

The final tables (Figure 3-10) summarize the mixing height values present within the output meteorological data file. If both rural and urban mixing heights can be employed with the requested dispersion model, tables are provided for each. Presented within the tables is the number of cases within height ranges (in meters) as a function of stability category. The DD and DN indicate daytime-neutral and nighttime-neutral. All moderate



```
    METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                 TODAY'S DATE AND TIME: 18-APR-88 AT 07:42:58
                  PROCESSING OF MERGED METEOROLOGICAL DATA


                 RURAL MIXING HEIGHT RESULTS
HEIGHT                 STABILITY CATEGORY
RANGE         A        B        C        DD       DN       EF      TOTAL

0-250       0.00     0.00     0.00     8.00     2.00     2.00    12.00
  500       0.00     0.00     0.00    13.00    27.00     1.00    41.00
 1000       0.00     0.00     0.00    11.00    12.00    14.00    37.00
 1500       0.00     0.00     1.00     3.00     0.00     2.00     6.00
 2000       0.00     0.00     0.00     0.00     0.00     0.00     0.00
>2000       0.00     0.00     0.00     0.00     0.00     0.00     0.00

PRESENT       0        0        1       35       41       19
MISSING       0        0        0        0        0        0
AVERAGE     0.00     0.00  1108.00   467.24   433.24   750.67




                 URBAN MIXING HEIGHT RESULTS
HEIGHT                 STABILITY CATEGORY
RANGE         A        B        C        DD       DN       EF      TOTAL

0-250       0.00     0.00     0.00     7.00     2.00     3.00    12.00
  500       0.00     0.00     0.00    12.00    27.00     2.00    41.00
 1000       0.00     0.00     0.00     8.00    12.00     4.00    24.00
 1500       0.00     0.00     1.00     8.00     0.00    10.00    19.00
 2000       0.00     0.00     0.00     0.00     0.00     0.00     0.00
>2000       0.00     0.00     0.00     0.00     0.00     0.00     0.00

PRESENT       0        0        1       35       41       19
MISSING       0        0        0        0        0        0
AVERAGE     0.00     0.00  1108.00   547.11   433.24   783.43
```

Figure 3-10. Sixth page of general report, for example where a RAMMET type output file is generated.

to stable cases are summarized together under the heading EF. The table provides a means for assessing the average mixing height as a function of stability, as well as providing a means for assessing the variation in mixing heights.

The summary presented on the fifth and sixth pages of the general report is especially useful in developing the input for dispersion models such as CDM and ISCLT. This summary can also be used in developing a sense for the variation in dispersive conditions within the generated output meteorological data file.

```
      METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                 TODAY'S DATE AND TIME: 18-APR-88 AT 07:42:58
                  PROCESSING OF MERGED METEOROLOGICAL DATA


           ********************************************************
           ***               JOB TERMINATED NORMALLY            ***
           ********************************************************


                     **** MPRM MESSAGE SUMMARY TABLE ****

        0- 9   10-19   20-29   30-39   40-49   50-59   60-69   70-79   TOTAL
      ----------------------------------------------------------------------

  MP
    E    0       0       0       0       0       0       0       0       0
    W    0       0       0       0       0       0       0       1       1
    I    1       1       0       0       0       0       0       1       3
    T    0       0       0       0       0       0       0       0       0
      ----------------------------------------------------------------------
         1       1       0       0       0       0       0       2       4

      ****   WARNING MESSAGES ****
       4 MP W70  FETCH: SWAPPED HR 23 INTO HR 24 FOR SF-DATA

      ****    ERROR MESSAGES  ****

              ---  NONE  ---
```

Figure 3-11. Seventh page of general report, for example where a RAMMET type output file is generated.

The final page of the general report (Figure 3-11) summarizes the messages written to the error/message file (defined by the JB ERR input image). Warning and error messages are listed beneath the message summary table. Various checks are made in an effort to provide useful warning and error messages to enable detection and correction of input run stream errors. Section 7 provides a full discussion on how to identify and understand the error messages.

SECTION 4

PROCESSING ON-SITE DATA AND OTHER SPECIAL OPTIONS

INTRODUCTION

This section presents examples illustrating the processing possibilities available through the use of the optional input images and the interpretation of the reports generated by MPRM. In particular,

- o Example run streams are presented illustrating how to extract and quality assess the data associated with each pathway separately. Such processing is especially useful when processing large data files.
- o Alternate processing choices available through the optional input images are illustrated.
- o The contents of the general report and error/message file are discussed.
- o The on-site data pathway is fully discussed.

STAGE 1 PROCESSING

- o Extraction of upper air soundings, mixing height data, surface observations, and on-site data from the raw data files
- o Processing these data through a series of quality assessment checks.

Suppose data are available for a 4-day period. What might the sequence of steps be in processing these data through data extraction and quality assessment?

Extract UA Data (Step 1)

We extract the upper air soundings and mixing height data from their respective raw data files (tape for upper air soundings, tape or disk for mixing height data). This step creates one data file containing both upper air and mixing height values. Also discussed are the optional input images: JB RUN, JB END, UA IN1, UA TOP and UA OFF.

```
JB STA
JB ERR DISK ERROR.LIS
JB RUN
JB FIN
UA STA
UA IN1 TAPE TAPE10 5600VB ASCII   13840
UA IN2 USER RAMZI.DAT (A5,3I2,1X,I5,13X,I5)  93815
UA IQA DISK IQAUA002.DAT
UA TOP 7000
UA LOC 93815 39.83N 84.05W +5
UA EXT 63 12 31 64 1 5
UA FIN
JB END
```

The JB RUN is useful for checking the syntax of the run stream input. When this input is present, the MPRM processor reads the entire run stream for syntax and then stop processing. This is a quick way to check the run stream for syntax errors. To actually process data remove this input image from the run stream.

The UA IN1 input is used for input of upper air observations. In the example shown above, the IN1 input opens access to a computer magnetic tape whose logical tape name is TAPE10. The logical tape name is assigned by the instructions given for mounting the tape. These instructions differ depending on the computer. For a VAX they would likely be DIGITAL Command

Language (DCL) instructions, for a UNIVAC they would be Executive Control Language (ECL) instructions, and for an IBM they would be Job Control Language (JCL) instructions. The procedures for mounting tapes differ from one computer site to the next, but the basic functions remain constant. An example of the DCL that performs this task is shown in Section 6. The data on TAPE10 are in the NWS TD-5600 format with a variable blocked structure, which is indicated by the VB following the 5600. (Note, variable blocking pertains to the NCDC format and has nothing to do with IBM variable blocking for data storage.) The information is stored on the tape in ASCII characters (as opposed to the IBM Extended Binary Coded Decimal Interchange Code (EBCDIC) characters). The 13840 is the station identification number.

The UA TOP input instructs the processor to store all upper air data at or below 7000 meters. This is thought of as a clipping height. All data above 7000 meters are "clipped," i.e., disregarded. The default value for the clipping height is 5000 meters.

The JB END input is an alternate means for identifying the end of the run stream input. The processor assumes that the end of the input data occurs whenever it encounters an end-of-file (EOF) or the JB END input image.

As discussed in Appendix A the general report file is optional, while the error/message report file is mandatory. What happens if no general report file is given? The printed output from MPRM, by default, is routed to logical UNIT 6, as defined in FORTRAN-77. On a mainframe computer, this is the default printer device for batch processing; on a PC, this is the screen for interactive processing. Each computer system has various means for controlling the output directed towards logical UNIT 6. In Section 3, we discussed how to direct UNIT 6 output on a PC.

The portion of the general report summarizing the messages within the error/message file is presented in Figure 4-1. In this example, there are 19 informational messages shown for UA-pathway data processing.

```
    METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

              TODAY'S DATE AND TIME: 14-APR-88 AT 08:59:48
              INITIAL PROCESSING ON RAW METEOROLOGICAL DATA


        ********************************************************
        ***           JOB TERMINATED NORMALLY               ***
        ********************************************************


                 **** MPRM MESSAGE SUMMARY TABLE ****

     0- 9   10-19   20-29   30-39   40-49   50-59   60-69   70-79   TOTAL
   -----------------------------------------------------------------------

JB
  E   0       0       0       0       0       0       0       0       0
  W   0       1       0       0       0       0       0       0       1
  I   0       7       0       0       0       0       0       0       7

UA
  E   0       0       0       0       0       0       0       0       0
  W   0       0       0       0       0       0       0       0       0
  I   0       0       0      19       0       0       0       0      19
   -----------------------------------------------------------------------
      0       8       0      19       0       0       0       0      27

     ****   WARNING MESSAGES ****
      0 JB W12 UAQAST: SUMMARY: MISSING/ERRORS IN UA-OQA CARD

     ****    ERROR MESSAGES   ****

            ---  NONE  ---
```

Figure 4-1. Second page of general report, for example where upper air soundings and mixing height data are extracted for a 6-day period.

The bulk of these informational messages are the result of automatic upper air data modifications made to the soundings during the extraction process. The automatic modifications are described in more detail in Section 5. In brief, modifications are made for unreasonable temperature changes in the vertical, resulting from an incorrect sign being assigned to a temperature value. Modifications are also made to remove unnecessary levels of data, resulting from inclusion of the extra standard (mandatory) reporting levels of data (such as the 900, 850, 500 mb levels of data). These mandatory levels are determined by interpolation from the original data. As indicated in the error/message file (Figure 4-2), 13 mandatory levels were deleted and the signs changed for two temperature values.

```
12 JB I19  SETUP: ENCOUNTERED END OF "JOB/RUN CARD"
 0 JB W12 UAQAST: SUMMARY: MISSING/ERRORS IN UA-OQA CARD
 0 JB I10   TEST: SUMMARY: NO SF-EXT CARD, NULL EXTRACT
 0 JB I11   TEST: SUMMARY: NO SF-IQA CARD, NULL QA
 0 JB I12   TEST: SUMMARY: NO SF-OQA CARD, NULL MERGE
 0 JB I10   TEST: SUMMARY: NO OS-EXT CARD, NULL EXTRACT
 0 JB I11   TEST: SUMMARY: NO OS-IQA CARD, NULL QA
 0 JB I12   TEST: SUMMARY: NO OS-OQA CARD, NULL MERGE
 0 UA I30  UAEXT: **** UPPER AIR EXTRACTION ****
 0 UA I36  UAEXT:*     *** AUTOMATIC SDG. CHECKS ARE ON
 1 UA I37 UAAUTO: 64 1 1/ 7; LVL  6 -TEMP. SIGN CHANGE
 1 UA I37 UAAUTO: 64 1 1/19;   450.MB -MAND. LVL DELETED
 1 UA I37 UAAUTO: 64 1 2/ 7;   900.MB -MAND. LVL DELETED
 2 UA I37 UAAUTO: 64 1 2/ 7;   850.MB -MAND. LVL DELETED
 1 UA I37 UAAUTO: 64 1 2/19;   950.MB -MAND. LVL DELETED
 2 UA I37 UAAUTO: 64 1 2/19;   900.MB -MAND. LVL DELETED
 3 UA I37 UAAUTO: 64 1 2/19;   600.MB -MAND. LVL DELETED
 2 UA I37 UAAUTO: 64 1 2/19; LVL  8 -TEMP. SIGN CHANGE
 1 UA I37 UAAUTO: 64 1 3/ 7;   700.MB -MAND. LVL DELETED
 1 UA I37 UAAUTO: 64 1 3/19;   900.MB -MAND. LVL DELETED
 1 UA I37 UAAUTO: 64 1 4/ 7;   850.MB -MAND. LVL DELETED
 2 UA I37 UAAUTO: 64 1 4/ 7;   500.MB -MAND. LVL DELETED
 3 UA I37 UAAUTO: 64 1 4/ 7;   450.MB -MAND. LVL DELETED
 1 UA I37 UAAUTO: 64 1 5/ 7;   950.MB -MAND. LVL DELETED
 1 UA I37 UAAUTO: 64 1 5/19;   900.MB -MAND. LVL DELETED
 6 UA I39 GETMIX: END-OF-FILE, END-OF-DATA
 0 UA I30  UAEXT:  11 SDGS AND    6 MIXING HTS EXTRACTED
```

Figure 4-2. Error/message file generated during a 6-day extraction period for upper air soundings and mixing height data.

Experience has shown that the modifications outlined are frequently useful, and for this reason, MPRM includes them as automatic procedures. However, these modifications can be deactivated through the use of the optional input image UA OFF.

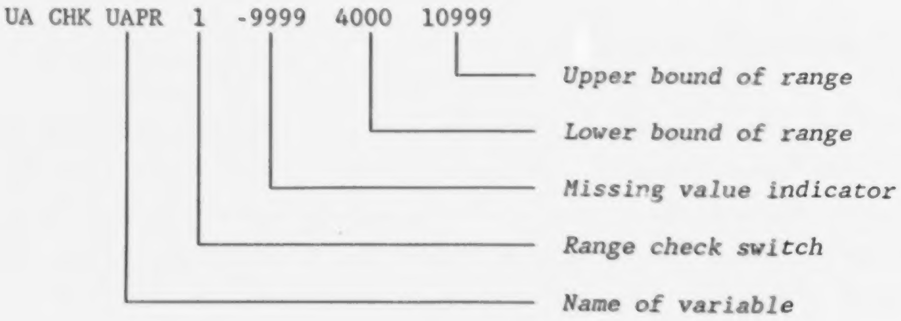
Quality Assess UA Data (Step 2)

Having extracted the UA data, we now process these data through Stage 1 quality assessment. With the information from the reports generated, one can use a text editor to alter suspect values. This process is continued until the UA data are ready for Stage 2 processing. Also discussed are the optional input images: JB OUT and UA CHK.

```
JB STA
JB OUT DISK REPORT.LIS
JB ERR DISK ERROR.LIS
JB FIN
UA STA
UA IQA DISK IQAUA002.DAT
UA OQA DISK OQAUA002.DAT
UA CHK UAPR 1 -9999 4000 10999
UA LOC 93815 75.97W 33.37N +5
UA FIN
JB END
```

There are not many differences between the above input and that given for step 1. The JB OUT image allows redirection of UNIT 6 output to a file. In this case, the file is REPORT.LIS. The most important differences are that the IN1 and IN2 input are not present. These are only needed for initial data extraction from the raw data files. For processing the UA data through quality assessment, the input data file is defined by the IQA data. The file defined by the Output-from-Quality-Assessment (OQA) input is used to store the data read from the IQA file as it is processed through the quality assessment checks. As discussed in Section 3, the format of the data written to the OQA file is identical to that for the IQA file.

Inspection of the example given above reveals another input that is unique to the assessment phase of Stage 1 processing, the CHK input, which is interpreted as:


UA CHK UAPR 1 -9999 4000 10999
Upper bound of range
Lower bound of range
Missing value indicator
Range check switch
Name of variable

The CHK input provides a means for redefining (overriding) the default settings used in during quality assessment. Each variable processed through the range checks is given a unique four-character name. A list of the names for the UA-pathway is given in Table C-1 in Appendix C. The units of values entered for the upper and lower bounds must be the same as those employed within the processor and defined in Appendix C.

In the example given, UAPR refers to the upper air atmospheric pressure. These are stored as tenths of millibars within the processor. Hence, the lower bound of 4000 is equivalent to 400 mb. The upper bound given is equivalent to 1099.9 mb.

The range check switch tells the processor how to perform the range check. A switch value of 1 excludes as valid values the upper and lower bounds. Hence, a value equal to the lower bound would be considered a violation, and a warning message would be listed to the error/message file. A switch value of 2 includes as valid values the upper and lower bounds. As an example of where the switch eases the specification of the range check bounds, consider the difference between mixing heights and snow amounts. A value for snow amount of 0 is logical, but a mixing height value of 0 is illogical.

The CHK input has a very special quality: the MPRM processor will 'remember' this input.

The processor incorporates the CHK input into the header record that is written to the OQA file. If these data are reprocessed, and the OQA file (output file from a previous quality assessment run) is the file defined as the IQA file (input file for a quality assessment run), the MPRM processor will pick up the previously defined CHK input and redefine the range check information accordingly, while reading the header record, thus 'remembering' the input. Therefore, the user does not have to continually repeat the CHK input. However, the CHK input can be given for the same variable as many times as desired. The processor will use the latest definition in performing the range checks, allowing the range checks to be altered as needed.

The first page of the general report (Figure 4-3) is a status report which basically presents a view of the processing environment within MPRM just <u>before</u> any attempts are made to read or process data from any of the data files. The first item on the status report is the MPRM heading, which includes the version number and the date the processor was run. This heading is standard and appears at the top of all output pages. Following the heading, within the body of the report, are the names of files to be used and the status of the pathway data files (OPEN or NOT OPEN). Also

```
METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

           TODAY'S DATE AND TIME: 14-APR-88 AT 09:28:20
           INITIAL PROCESSING ON RAW METEOROLOGICAL DATA


          STATUS REPORT PRIOR TO BEGINNING PROCESSOR RUN

1.  REPORT FILE NAMES

     ERROR MESSAGES: ERROR.LIS
     SUMMARY OF RUN: REPORT.LIS


2.  UPPER AIR DATA

     SITE ID    LATITUDE(DEG.)   LONGITUDE(DEG.)
      93815        33.37N            75.97W

     THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
      QUALITY ASSESSMENT ONLY

     EXTRACT OUTPUT-     OPEN: IQAUA002.DAT
     QA OUTPUT     -     OPEN: OQAUA002.DAT


3.  NWS SURFACE DATA

     THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
      NONE, NO DATA TO BE PROCESSED ON THIS PATH


4.  ON-SITE DATA

     THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
      NONE, NO DATA TO BE PROCESSED ON THIS PATH
```

Figure 4-3. First page of general report, for example where UA-pathway data are submitted for quality assessment.

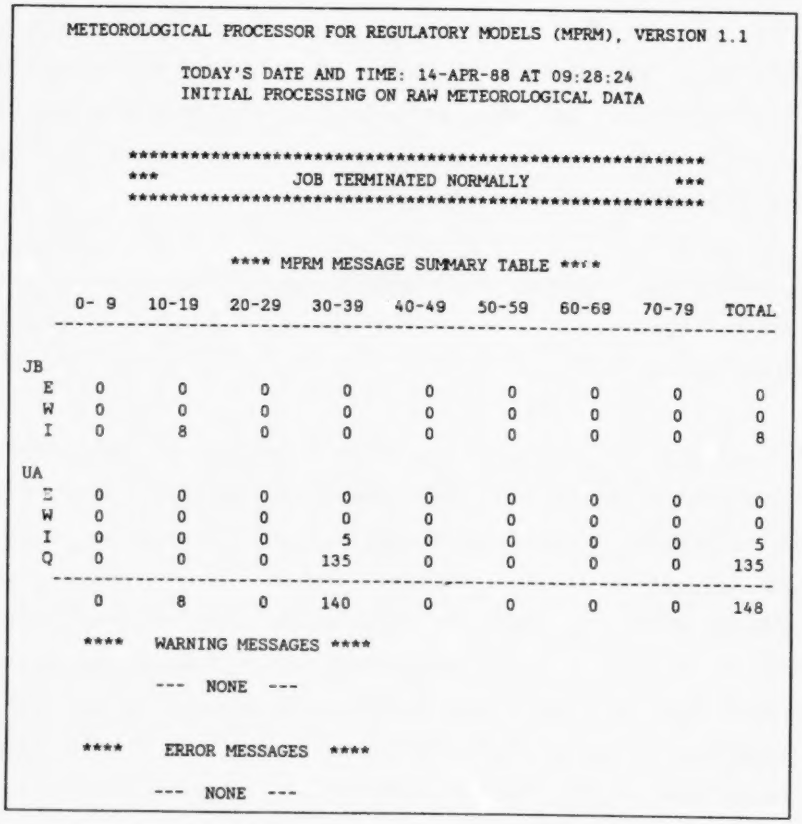
reported are other pertinent information such as the extraction dates, the site identifier, and the latitude and longitude. In the example presented, since a file was designated for the general report, the report was written to the file named REPORT.LIS. Within item 2 (UPPER AIR DATA) is given the station identification and the latitude and longitude for the UA-pathway data. Below this is a message summarizing the processes that MPRM is anticipated to perform on the UA-pathway data.

The second page (Figure 4-4) summarizes the messages listed to the error/message file. In this case, 135 quality assessment messages were generated.

The last page of the general report (Figure 4-5) summarizes the quality assessment checks, or audit summary. In this case, only the twice-daily mixing height values were summarized. These are the only variables audited by default on the UA-pathway. One of the six morning urban mixing height values, UAM1, was found to be greater than the range check upper bound (500 m) and three of the afternoon mixing height values, UAM2, were found to be lower than the range check lower bound (500 m). Whether any of these mixing height values are unreasonable can only be determined through inspection of the values coupled with expert judgment.

The range check messages (refer to Figure 4-6) provide sufficient information to identify each occurrence of a range check violation - the bound violated, LB for lower bound and UB for upper bound, the value of the bound, and the data value causing the message. The second line of the message provides the year, month, day, and hour.

The message code in the second range check message starts with an I rather than a Q. When the daily sounding and mixing height data were extracted, the mixing heights were repeated with each sounding during the day; therefore, any mixing height violations after the first one for the day were labeled as informational messages. This provides an accurate



```
     METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                TODAY'S DATE AND TIME: 14-APR-88 AT 09:28:24
                INITIAL PROCESSING ON RAW METEOROLOGICAL DATA

          ********************************************************
          ***               JOB TERMINATED NORMALLY            ***
          ********************************************************


                    **** MPRM MESSAGE SUMMARY TABLE ****

      0- 9   10-19   20-29   30-39   40-49   50-59   60-69   70-79   TOTAL
    ----------------------------------------------------------------------

 JB
   E  0       0       0       0       0       0       0       0       0
   W  0       0       0       0       0       0       0       0       0
   I  0       8       0       0       0       0       0       0       8

 UA
   E  0       0       0       0       0       0       0       0       0
   W  0       0       0       0       0       0       0       0       0
   I  0       0       0       5       0       0       0       0       5
   Q  0       0       0     135       0       0       0       0     135
    ----------------------------------------------------------------------
      0       8       0     140       0       0       0       0     148

     ****  WARNING MESSAGES ****

           ---  NONE  ---


     ****   ERROR MESSAGES   ****

           ---  NONE  ---
```

Figure 4-4. Second page of general report, for example where UA-pathway data are submitted for quality assessment.

count of the number of acceptable mixing heights in the audit summary and, at the same time, reminds the user that the mixing heights appear in the input file to quality assessment in multiple places.

As shown and discussed above, part of the information given within the general report is a summary of the occurrences of range check violations for several of the meteorological variables. Through the use of AUD input, other variables on the UA-pathway can be added to the list of variables summarized within the audit report. On the UA-pathway, only the twice-daily mixing height values (NCDC TD-9689 data) are audited by default. The

```
      METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                 TODAY'S DATE AND TIME: 14-APR-88 AT 09:28:26


            **********************************************************
            ***              JOB TERMINATED NORMALLY               ***
            **********************************************************


                        **** SUMMARY OF THE QA AUDIT ****


MIXING HTS          |------VIOLATION SUMMARY------|  |-----TEST VALUES-----|
             TOTAL      #     LOWER  UPPER     %     MISSING  LOWER   UPPER
             # OBS  MISSING   BOUND  BOUND  ACCEPTED   FLAG   BOUND   BOUND
    UAM1       6        0       0      1     83.33   -9999.0,   50.0,  500.0
    UAM2       6        0       3      0     50.00   -9999.0,  500.0, 3500.0
  THERE IS NO AUDIT TRAIL FOR    SOUNDINGS

  THIS CONCLUDES THE AUDIT TRAIL
```

Figure 4-5. Last page of general report, for example where UA-pathway data are submitted for quality assessment.

```
       11 JB I19  SETUP: ENCOUNTERED END OF "JOB/RUN CARD"
        0 JB I10   TEST: SUMMARY: NO UA-EXT CARD, NULL EXTRACT
        0 JB I10   TEST: SUMMARY: NO SF-EXT CARD, NULL EXTRACT
        0 JB I11   TEST: SUMMARY: NO SF-IQA CARD, NULL QA
        0 JB I12   TEST: SUMMARY: NO SF-OQA CARD, NULL MERGE
        0 JB I10   TEST: SUMMARY: NO OS-EXT CARD, NULL EXTRACT
        0 JB I11   TEST: SUMMARY: NO OS-IQA CARD, NULL QA
        0 JB I12   TEST: SUMMARY: NO OS-OQA CARD, NULL MERGE
                                    .
                                    .
                                    .
      107 UA Q37 INTECK: LB:          500 UAM2:        155
      107 UA           : ON  64/01/01/07
                                    .
                                    .
                                    .
      119 UA I37 INTECK: LB:          500 UAM2:        155
      119 UA           : ON  64/01/01/19
                                    .
                                    .
                                    .
      407 UA Q38 INTECK: UB:          500 UAM1:       1108
      407 UA           : ON  64/01/04/07
                                    .
                                    .
                                    .
       12 UA I39 UAQASM: EOF AFTER UA REPORT #  11 (NORMAL)
```

Figure 4-6. Partial listing of error/message file generated during a 6-day quality assessment period for upper air soundings and mixing height data.

syntax of the AUD input is given in Appendix B. An example will be presented later within the discussion of the example run stream for quality assessing the NWS hourly surface weather observations (SF-pathway).

Extract SF Data (Step 3)

In this step we extract the hourly surface data from their raw data file (disk). This creates a new data file containing the extracted NWS hourly weather observations. Each hour's observation requires two lines in the output file.

In comparing the run stream given below with that given for step 1, there are many similarities. The reuse of the general report and error files reduces the number of files created. Furthermore, these files are of little use once the user has successfully completed each processing step.

```
JB STA
JB ERR DISK ERROR.LIS
JB OUT DISK REPORT.LIS
JB RUN
JB FIN
SF STA
SF IN2 DISK RAMSFC.DAT CD144FB 93814
SF IQA DISK IQASF002.DAT
SF LOC 93814 84.05W 39.83N 0
SF EXT 64 01 01 64 01 04
SF FIN
```

As no new input images are illustrated in this run stream, portions of the reports are illustrated for comparison with the examples discussed in previous examples. As shown in Figure 4-7, there were several informational messages and one warning message. This error/message file is similar in content and interpretation to the error/message file generated for the second upper air example (refer to Figure 4-6).

```
 11 JB I19  SETUP: FOUND "END OF FILE" ON DEVICE DEVIN  5
  0 JB I10   TEST: SUMMARY: NO UA-EXT CARD, NULL EXTRACT
  0 JB I11   TEST: SUMMARY: NO UA-IQA CARD, NULL QA
  0 JB I12   TEST: SUMMARY: NO UA-OQA CARD, NULL MERGE
  0 JB W12 SFQAST: SUMMARY: MISSING/ERRORS IN SF-OQA CARD
  0 JB I10   TEST: SUMMARY: NO OS-EXT CARD, NULL EXTRACT
  0 JB I11   TEST: SUMMARY: NO OS-IQA CARD, NULL QA
  0 JB I12   TEST: SUMMARY: NO OS-OQA CARD, NULL MERGE
  0 SF I40  SFEXT: *** SURFACE OBSERVATION EXTRACTION ***
 96 SF I49 GETSFC: END-OF-FILE, END-OF-DATA
 96 SF I49  SFEXT:   96 SURFACE OBSERVATIONS EXTRACTED
```

Figure 4-7. Error/message file, for example where data are extracted for use on the SF-pathway.

```
  METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

             TODAY'S DATE AND TIME: 14-APR-88 AT 09:25:07
             INITIAL PROCESSING ON RAW METEOROLOGICAL DATA


        ********************************************************
        ***              JOB TERMINATED NORMALLY             ***
        ********************************************************


                  **** MPRM MESSAGE SUMMARY TABLE ****

      0- 9   10-19   20-29   30-39   40-49   50-59   60-69   70-79   TOTAL
    -----------------------------------------------------------------------

 JB
   E    0       0       0       0       0       0       0       0       0
   W    0       1       0       0       0       0       0       0       1
   I    0       7       0       0       0       0       0       0       7

 SF
   E    0       0       0       0       0       0       0       0       0
   W    0       0       0       0       0       0       0       0       0
   I    0       0       0       0       3       0       0       0       3
    -----------------------------------------------------------------------
        0       8       0       0       3       0       0       0      11

      ****  WARNING MESSAGES ****
       0 JB W12 SFQAST: SUMMARY: MISSING/ERRORS IN SF-OQA CARD


      ****    ERROR MESSAGES  ****

             ---  NONE  ---
```

Figure 4-8. Second page of general report, for example where data are extracted for use on the SF-pathway.

The final summary report (Figure 4-8) is quite similar to that for the second upper air example (refer to Figure 4-4). The three messages specifically issued for the SF-pathway were only informational. They were concerned with accessing the data files for the surface observations and reporting how many observations were processed.

Looking at the run stream SF EXT input, we see that the intention was to extract 4 days of data (January 1 - January 4, inclusive). With 24 hours in a day that translates to 96 hours. In Figure 4-7, the message that 96 observations were processed is an indication that the data requested were indeed found and extracted.

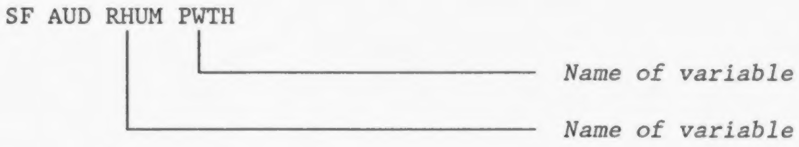
Quality Assess SF Data (Step 4)

The SF-pathway data are now processed through the quality assessment portion of Stage 1 processing. As with the UA data, we review the reports generated, and using a text editor, alter suspect values. This process is continued until the SF-pathway data are ready for Stage 2 processing.

```
JB STA
JB OUT DISK REPORT.LIS
JB ERR DISK ERROR.LIS
JB FIN
SF STA
SF IQA DISK IQASF002.DAT
SF OQA DISK OQASF002.DAT
SF AUD RHUM PWTH
SF LOC 93814 84.05W 39.83N +0
SF FIN
JB END
```

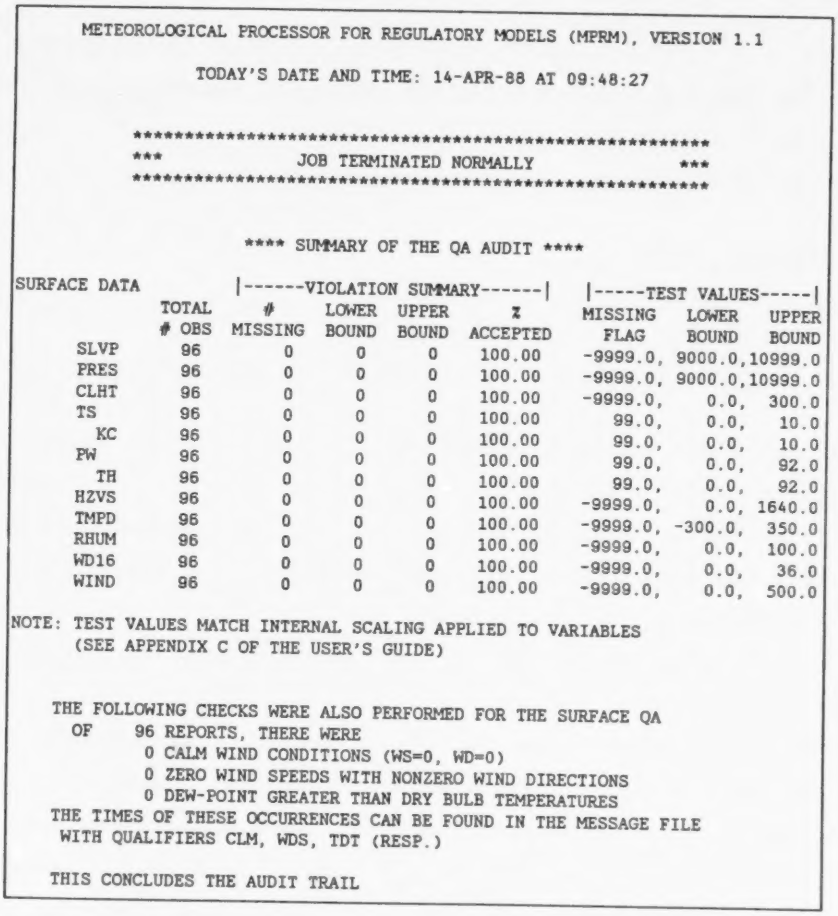
The new optional input illustrated in this example is SF AUD. Comparison of the above run stream with that given in step 2 for the UA-pathway quality assessment reveals that the two run streams are almost identical. This is no surprise, especially since the logic associated with quality assessment is identical regardless of the data involved. The data given as input (IQA input) is to be checked and rewritten to the output file (OQA input). Warnings and messages are written to the error report file (JB ERR input) and summarized in the general report file (JB OUT input).

In the upper air example, the UA CHK input was discussed. This input can also be used when processing SF and OS data as needed. Similarly, the AUD keyword to be discussed now can be used in processing UA and OS data.



The AUD input can be repeated as often as needed in order to list all the variables to be added to the audit report. Several variables can appear on one input image, with the restriction that no field extends beyond column 80. The default list of audit variables on the SF-pathway are: sea-level pressure, station pressure, ceiling height, sky cover (total and opaque), horizontal visibility, dry bulb temperature, wind direction, and wind speed. The above AUD input adds RHUM and PWTH to this default list of audit variables. RHUM is the variable name for relative humidity and PWTH is the variable name for present weather. Present weather information might be useful in a dispersion analysis if one anticipated that a pollutant might be "washed out" of the atmosphere during a precipitation event, like a rain shower, and therefore it would no longer be available for transport further downwind. Such information would be relevant in attempting to compare values of gaseous concentrations observed versus concentration values estimated by a dispersion model which makes no provision for pollutant washout.

The AUD input differs from the CHK input in that the AUD input is not 'remembered' by the MPRM processor. Hence, any additional variables that are to be added to the audit report must be repeated with the AUD input each time quality assessment is performed.



```
        METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                      TODAY'S DATE AND TIME: 14-APR-88 AT 09:48:27


             **********************************************************
             ***                JOB TERMINATED NORMALLY             ***
             **********************************************************


                         **** SUMMARY OF THE QA AUDIT ****

SURFACE DATA            |------VIOLATION SUMMARY------|   |-----TEST VALUES-----|
                 TOTAL     #     LOWER  UPPER     %       MISSING   LOWER   UPPER
                 # OBS  MISSING  BOUND  BOUND  ACCEPTED    FLAG     BOUND   BOUND
      SLVP        96        0      0      0     100.00    -9999.0, 9000.0,10999.0
      PRES        96        0      0      0     100.00    -9999.0, 9000.0,10999.0
      CLHT        96        0      0      0     100.00    -9999.0,    0.0,  300.0
      TS          96        0      0      0     100.00       99.0,    0.0,   10.0
        KC        96        0      0      0     100.00       99.0,    0.0,   10.0
      PW          96        0      0      0     100.00       99.0,    0.0,   92.0
        TH        96        0      0      0     100.00       99.0,    0.0,   92.0
      HZVS        96        0      0      0     100.00    -9999.0,    0.0, 1640.0
      TMPD        96        0      0      0     100.00    -9999.0, -300.0,  350.0
      RHUM        96        0      0      0     100.00    -9999.0,    0.0,  100.0
      WD16        96        0      0      0     100.00    -9999.0,    0.0,   36.0
      WIND        96        0      0      0     100.00    -9999.0,    0.0,  500.0

NOTE: TEST VALUES MATCH INTERNAL SCALING APPLIED TO VARIABLES
      (SEE APPENDIX C OF THE USER'S GUIDE)


   THE FOLLOWING CHECKS WERE ALSO PERFORMED FOR THE SURFACE QA
     OF    96 REPORTS, THERE WERE
              0 CALM WIND CONDITIONS (WS=0, WD=0)
              0 ZERO WIND SPEEDS WITH NONZERO WIND DIRECTIONS
              0 DEW-POINT GREATER THAN DRY BULB TEMPERATURES
   THE TIMES OF THESE OCCURRENCES CAN BE FOUND IN THE MESSAGE FILE
    WITH QUALIFIERS CLM, WDS, TDT (RESP.)

   THIS CONCLUDES THE AUDIT TRAIL
```

Figure 4-9. Last page of general report, for example where SF data are checked for integrity.

The audit summary (Figure 4-9) is similar in structure to the one discussed for the UA data (refer to Figure 4-5) but different in content. The two primary differences between the upper air audit and the surface audit are that there are no multilevel SF data and that there are SF variables containing two pieces of information. These 'double duty' variables are two integer variables combined to form a single integer variable. Table C-2 shows which SF variables are composed of two variables. These combined variables are separated before use in quality assessment checks or use in development of meteorological data files.

In Figure 4-9, this latter difference can be seen near the middle of the report where the four-character variable TSKC has been split into two variables, TS and KC. The variable TSKC contains information regarding both total sky cover and opaque sky cover. In the audit report, the line called TS reports the audit results for total sky cover. The line called KC reports the audit results for opaque cloud cover. The variable PWTH is another example where two fields of information are stored together. The PWTH variable contains information regarding both the prevailing and secondary weather occurring during the observation. In the audit report, the line called PW reports the audit results for the prevailing weather data, and the line called TH reports the audit results for the secondary weather data.

Because there were no quality assessment violations and no missing data, all data were accepted. While somewhat uninteresting, this is what is hoped for when reasonable upper and lower bounds are specified. The upper and lower bounds and the missing value indicator employed in the quality assessment checks are shown for each variable on the right side of the table. The default values and multipliers used for each variable are shown in Appendix C.

Besides checking individual variables against upper and lower bounds, several other checks are made involving comparison of two variables within the same observation. The results of these checks are presented below the audit summary table. The additional comparison checks are:

- Dew-point temperature exceeding dry bulb temperature
- Defined wind direction with zero wind speed
- Occurrences of calm wind conditions.

Extract and Quality Assess OS Data (Step 5)

In this step, we extract and quality assess the on-site data from their raw data files. All data extracted will automatically be processed through the quality assessment checks. Notice that no provisions have been made for processing these data from a computer tape.

Unique to the above examples for processing the NWS meteorological data, the format of the original data files was known, as NCDC supplies these data in only several well-defined formats. This assumption is not valid in the context of user collected on-site meteorological data. There is no standard for storage of these data, and furthermore, there cannot be. The variety of measurements possible preclude development of such a standard.

Therefore, the MPRM must be "told" the storage format. To reduce the pain to the user, MPRM "remembers" the format. This occurs when MPRM first reads the on-site data. The first time the data are read, the data format is defined using special input records (MAP and FMT). MPRM stores, as part of the header records to these data, the MAP and FMT input images and uses these header records in all successive reads.

Below is an example of the run stream for the initial extraction and processing of on-site data. Comparison of this run stream with that given in steps 1 and 3 reveals that the run streams are very similar, down to the point where the MAP and FMT input are given. This is no surprise, since the logic associated with initially reading a data file is identical regardless of the data involved.

The one difference is that for the UA and SF data, IN1 and IN2 input were used to define the original source files of data, whereas for the OS data, the IQA input is used to define the source file of OS data.

The data given as input (IQA input) are checked, hourly averages are computed if needed, and the hourly averages are written to the output file (OQA input). Warnings and messages are written to the error/message file (JB ERR input) and summarized in the general report file (JB OUT input).

```
JB STA
JB OUT DISK REPORT.LIS
JB ERR DISK ERROR.LIS
JB FIN
OS STA
OS IQA DISK IQAOS001.DAT
OS OQA DISK OQAOS001.DAT
OS EXT 64 1 1 64 1 4
OS LOC 9381464 39.07N 84.68W 0
OS AVG 4
OS DT1 2 10
OS MAP DAT01 OSYR OSMO OSDY OSHR OSMN DT01
OS MAP DAT02 HT01 WS01
OS MAP DAT03 HT02 TT02 WS02 WD02 SA02
OS FMT DAT01 (5X,3(I2.2),5X,2I2,10X,F10.4)
OS FMT DAT02 (1X,2F10.4)
OS FMT DAT03 (1X,5F10.4)
OS SFC SETUP ANNUAL 2
OS SFC VALUES 1  1  0.6  0.5  0.3
OS SFC VALUES 1  2  0.8  0.6  0.1
OS SFC SECTORS 1  30  150
OS SFC SECTORS 2 150   30
OS CHK DT01 1 -999 -2 10
OS CHK WS 1 -999 0 50
OS CHK WD 1 -999 0 360
OS CHK TT 1 -999 -30 35
OS CHK SA 1 -999 0 35
OS FIN
JB END
```

The OS AVG input image, unique to the OS-pathway, defines the maximum number of data records expected for each hour, OSAVG. The default value for OSAVG is 1. In the example given, the AVG keyword instructs MPRM that up to four data records are provided each hour (OSAVG is set to 4). This would be the case if the original source files of OS data contained data for each 15-minute period. The logic within MPRM to accomplish the averaging is quite simple. It reads the data records until a new hour is encountered. The program compares the number of valid data values encountered versus the minimum number of values accepted for computation of an hourly average. The minimum number is computed as OSAVG/2 (if OSAVG is an even number) or as OSAVG/2 + 1 (if OSAVG is an odd number). The AVG input image is only needed the first time the OS data are processed. Thereafter, only hourly averages are available for processing.

The DT1 input signals that there are temperature difference measurements available, Delta-T, and that the measurements were made at 2 and 10 m above the ground. The convention followed in MPRM is that the temperature difference value represents the upper measurement height temperature minus the lower measurement height temperature. There can be up to three temperature differences (DT1, DT2, and DT3) given as input. The measurement heights for each would be entered as they were for DT1. Temperature differences are treated as scalar input as they represent a single measurement (typically a voltage potential or change in resistance).

The next three input images employ the MAP keyword. They describe to the processor the sequence and format (in the FORTRAN sense) of meteorological variables available for input for one time period. All the possible variables have been given 4-character names which are listed in Table C-3 in Appendix C. The MAP DATxx defines the sequence of variables available for input to the processor. The xx indicates the record number, as DAT01 is the first record of data. It is required that each observation be labeled with a date and time, and that this be given before the rest of the data values. Below is an example of what the first six data records of on-site data might look like (Figure 4-10). As the data have a specific format, scales are given at the top and bottom of the table to ease interpretation.

	123456789012345678901234567890123456789012345678901234567890				
Record number	Sample On-Site (OS) Input Data				
1	640201	1005		-0.01	
2	2.0	2.1			
3	10.0	3.2	2.0	181.2	10.3
4	640201	1010		-0.01	
5	2.0	2.3			
6	10.0	3.7	2.1	181.0	9.7
	123456789012345678901234567890123456789012345678901234567890				

Figure 4-10. Example of on-site data.

In the example, records 1 through 3 are for the first time period and the next three records are for the next time period. The first record for each time period begins with a date and time group (OSYR, OSMO, OSDY, OSHR OSMN), followed by the Delta-T value (DT01). Record 1 deciphered is February 2, 1964, at 10:05 a.m. The temperature difference value is -0.01 ^{0}C (given the DT1 input, this measurement was taken between 10 and 2 m).

The DAT02 input declares that the second read of input data consists of a measurement height and wind speed. HTyy indicates measurement height, where the yy indicates level above ground. For instance, HT02 is above HT01. Likewise, WSyy indicates wind speed, and the 01 means this value was measured at the lowest measurement height, HT01. These is no relationship assumed between the data record sequence number xx, given in DATxx, and the measurement level yy, given in the variable name. If all the wind speed measurements had been reported on the second record, then the DAT02 input would have looked like:

```
OS MAP DAT02 WS01 WS02
          or
OS MAP DAT02 WS02 WS01
```

depending on the order the wind speed values are given within the file.

Obviously, there are many variations possible. Another example is discussed in Appendix B. The primary constraints to remember are:

- o Date and time (the order is not important) must be given first for each on-site observation. The time must, at the very least, define the hour to be associated with the observation. All date and time data must be capable of being read using INTEGER format.

- o The other data are given next, following the date and time. There can be up to 20 records (DATxx records) of input data. No more than 40 values can be given in any one record.

The FMT input images define the FORTRAN FORMAT to be employed for reading each input record. A FMT DAT01 image is used to define the format for the first scalar record.

The FMT DAT01 record shown in the example demonstrates how the date and time, made up of five fields of information - year, month, day, hour, and minutes - may appear in the input data set as two integer values. The year, month, and day are given as 640201 and the hour and minutes are given as 1005. By appropriate specification of the FORTRAN FORMAT, the MPRM can handle various data file structures. For instance, if the time were stored as 10:05, a format with I2.2,1X,I2.2 rather than 2I2.2 would be used.

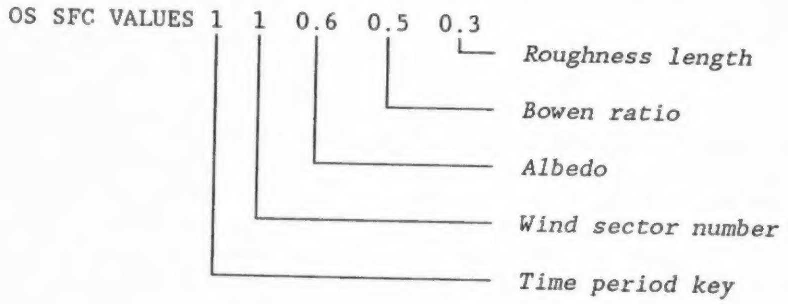
The formats given in the FMT input are used by the processor in listing the data values to the file specified in the OQA input. By using 3I2.2 rather than 3I2 in our format specification, the date group, 640201, would be written to the OQA file as 640201. Using 3I2 would result in the date group, 640201, becoming 64 2 1 in the OQA file. The leading zeros are lost with the 3I2 format. It is easier to read with the leading zeros; therefore, use of I2.2 style formats is recommended in specifying the date and time FMT input.

Not all variables appearing in the input data file have to be mapped. Only those variables the user believes will be useful in the final application are required, whether it be dispersion modeling or other analyses. With proper usage of the X or T format specifier, variables can be skipped; with careful usage of the / format specifier, entire records can be skipped. The format statements defined by the FMT input images are used in all processing involving reading or writing of the on-site data from data files. Hence, if X, T or / format specifiers have been employed, the information skipped in the original raw data file will appear as blanks in subsequent files.

The format statements defined by the FMT input images are used in all processing involving reading or writing of the on-site data from data files. If in the course of quality assessment it is found necessary to edit the on-site data file, be sure not to alter the data format, or read errors will occur in subsequent attempts to process the data.

The SFC input is optional. However, it is recommended that the SFC input be given whenever on-site data are present. The SFC input provides the processor with a description of the characteristics of the measurement site. These characteristics are described in terms of the surface albedo, the Bowen ratio, and the surface roughness length. The albedo is the fraction of radiation reflected at the surface (mostly incoming solar radiation). Typical values range from 0.1 for thick deciduous forests to 0.65 for fresh snow. The Bowen ratio is H/H_e, where H is the upward sensible heat flux and H_e is the heat flux used in evaporation. The Bowen ratio varies from 0.1 over water to 10.0 in desert. In principle, the surface roughness length is the height at which the horizontal wind speed is typically zero. Roughness length values range from less than 1 cm over a calm water surface to 1 m or more over a forest. The default values for albedo, Bowen ratio, and roughness length are 0.25, 0.75, and 0.15 m, respectively. These are typical of cultivated land with average moisture content.

Through the use of the SFC input, the specification of these site characteristics can be varied according to the wind direction and the month of the year. The SFC SETUP input specifies whether the new values apply annually, seasonally, or monthly and how many wind direction sectors will be employed in specifying the values. In the example, ANNUAL values are given for two wind sectors. The two SFC VALUES input images define the values for the albedo, the Bowen ratio, and the roughness length (in that order). The first SFC VALUES input is deciphered as:



```
OS SFC VALUES 1  1  0.6  0.5  0.3
```

The time period key is defined with respect to how frequently the values are varied throughout the year. For annual definitions, the time period key is always 1. For cases where the values are to be varied either seasonally or monthly, refer to the discussion and example given in Appendix B for the SFC keyword. The wind sector number defines which wind sector, as defined on the SFC SETUP input image, the site characteristics given are applicable.

The last two SFC SECTOR input images define the beginning and ending azimuths of the wind direction sectors. The sectors are defined in terms of wind direction (in the meteorological sense, i.e., the direction from which the wind is blowing with North associated with the angle 360°). The beginning and ending directions are defined in a clockwise sense. Hence, for the example run stream, the first sector is for wind directions from the east to southeast, between 30 and 150 degrees. For hours having winds from 30 to 150 degrees, the albedo, the Bowen ratio, and the roughness length are to be 0.6, 0.5 and 0.3 m, respectively.

For the example given, the measurement heights for the multilevel variables were defined within the data set, as part of the data record. This is not always the case. In fact, it is likely the exception rather than the rule. Since measurement heights are fixed, they need not be repeated within each data record. For data sets where the measurement heights for the multilevel variables are not given within the data records, use the OS HGT input. For the above example, the heights could have been defined as:

```
OS HGT 2 2.0 10
```

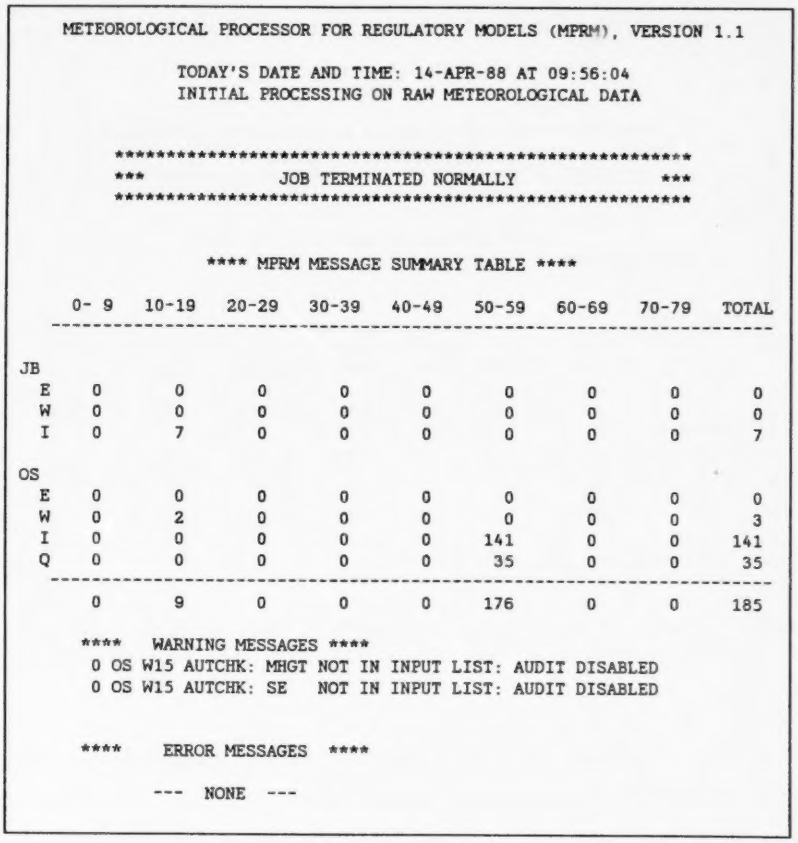
This indicates that there are two measurement heights, the first (and lowest) at 2 m above ground and the second at 10 m above ground.

The general report resulting from the example discussed is shown in Figures 4-11, 4-12 and 4-13. As can be seen from inspection of Figure 4-12, there were 35 range violation messages generated and 141 informational messages. Of the 141 informational messages, 140 were due to range violations during quality assessment. If the input data are more frequent than one observation per hour, then all intrahour range (i.e., quarter-hour intervals in the example) violations are reported as informational messages (I). If the hourly average violates the prescribed range, the violation is reported as a quality assessment message (Q). Of the default audit variables for the on-site data, two were not found in the data map: mixing height, and standard deviation of the vertical wind direction fluctuations.

```
METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

           TODAY'S DATE AND TIME: 14-APR-88 AT 09:55:48
           INITIAL PROCESSING ON RAW METEOROLOGICAL DATA


          STATUS REPORT PRIOR TO BEGINNING PROCESSOR RUN

1.  REPORT FILE NAMES

     ERROR MESSAGES: ERROR.LIS
     SUMMARY OF RUN: REPORT.LIS


2.  UPPER AIR DATA

     THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
      NONE, NO DATA TO BE PROCESSED ON THIS PATH


3.  NWS SURFACE DATA

     THE PROCESS(ES) MPRM ANTICIPATES TO PEPFORM ARE
      NONE, NO DATA TO BE PROCESSED ON THIS PATH


4.  ON-SITE DATA

     SITE ID    LATITUDE(DEG.)   LONGITUDE(DEG.)
     KINCAID        39.07N            84.68W

     THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
      EXTRACT AND QUALITY ASSESSMENT

     EXTRACT OUTPUT-    OPEN: IQAOS001.DAT
     QA OUTPUT     -    OPEN: OQAOS001.DAT

     THE EXTRACT DATES ARE:    STARTING:  1-JAN-64
                                 ENDING:  4-JAN-64
```

Figure 4-11. First page of general report, for example where on-site data are extracted and submitted for quality assessment.

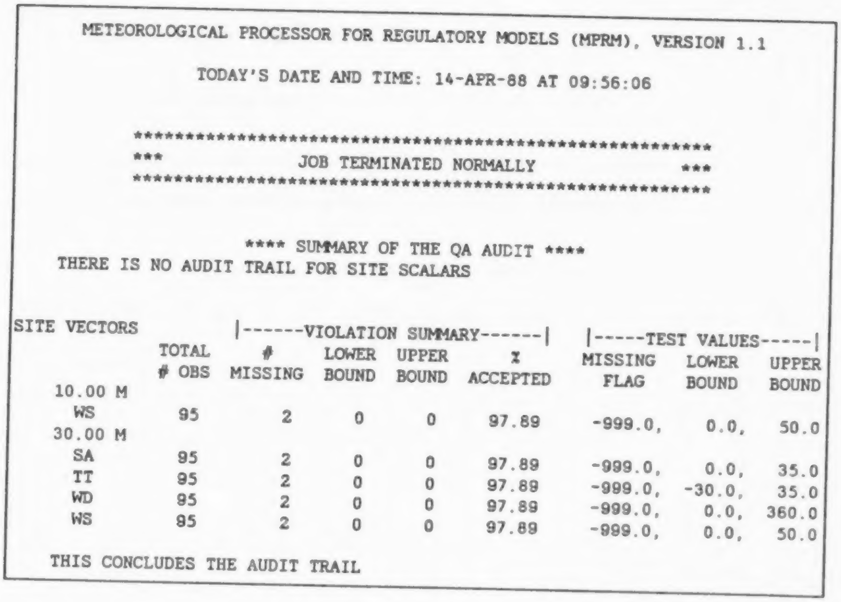
These were automatically removed from the audit list, as indicated by the warning messages listed beneath the message summary table (Figure 4-12). The audit summary (Figure 4-13) reports that there are several values missing within the hourly data. For those data present within the audit report, all but two passed the range checks for each variable.



```
        METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                    TODAY'S DATE AND TIME: 14-APR-88 AT 09:56:04
                    INITIAL PROCESSING ON RAW METEOROLOGICAL DATA


             ********************************************************
             ***               JOB TERMINATED NORMALLY            ***
             ********************************************************


                      **** MPRM MESSAGE SUMMARY TABLE ****

        0- 9   10-19   20-29   30-39   40-49   50-59   60-69   70-79   TOTAL
     ----------------------------------------------------------------------

  JB
    E    0       0       0       0       0       0       0       0       0
    W    0       0       0       0       0       0       0       0       0
    I    0       7       0       0       0       0       0       0       7

  OS
    E    0       0       0       0       0       0       0       0       0
    W    0       2       0       0       0       0       0       0       3
    I    0       0       0       0       0     141       0       0     141
    Q    0       0       0       0       0      35       0       0      35
     ----------------------------------------------------------------------
         0       9       0       0       0     176       0       0     185

        ****  WARNING MESSAGES ****
         0 OS W15 AUTCHK: MHGT NOT IN INPUT LIST: AUDIT DISABLED
         0 OS W15 AUTCHK: SE   NOT IN INPUT LIST: AUDIT DISABLED


        ****    ERROR MESSAGES  ****

              ---  NONE  ---
```

Figure 4-12. Second page of general report, for example where on-site data are extracted and submitted for quality assessment.

The message summary table (Figure 4-12) states that there are 176 messages generated concerning the on-site variables with error codes in the range of 50 to 59. From an inspection of the error message file, we quickly see that most of these messages resulted from range check violations involving the temperature differences. Figure 4-14 presents a partial listing of these messages.



```
          METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                     TODAY'S DATE AND TIME: 14-APR-88 AT 09:56:06


        ***********************************************************
        ***              JOB TERMINATED NORMALLY                ***
        ***********************************************************


                    **** SUMMARY OF THE QA AUDIT ****
    THERE IS NO AUDIT TRAIL FOR SITE SCALARS

SITE VECTORS        |------VIOLATION SUMMARY------|  |-----TEST VALUES-----|
              TOTAL     #     LOWER  UPPER     %     MISSING   LOWER   UPPER
              # OBS  MISSING  BOUND  BOUND  ACCEPTED   FLAG    BOUND   BOUND
    10.00 M
      WS        95       2      0      0     97.89    -999.0,    0.0,   50.0
    30.00 M
      SA        95       2      0      0     97.89    -999.0,    0.0,   35.0
      TT        95       2      0      0     97.89    -999.0,  -30.0,   35.0
      WD        95       2      0      0     97.89    -999.0,    0.0,  360.0
      WS        95       2      0      0     97.89    -999.0,    0.0,   50.0

    THIS CONCLUDES THE AUDIT TRAIL
```

Figure 4-13. Final page of general report, for example where on-site data are extracted and submitted for quality assessment.

Inspection of these messages suggest that the reported temperature differences sometimes exceed the range check bounds. These messages are best understood in light of how the on-site data are extracted and processed. As the data are read in, checks are made to determine if the data are within the dates specified for extraction. Once it is determined that the data are acceptable for inclusion within the extracted data set, each variable is passed through the range checks. In the example, this would occur for each of the 15-minute periods. Any range check messages generated during this phase of the processing are preceded with a number which is a concatenation of the Julian day and hour. For instance, the 100 at the beginning of the range check message for a Delta-T value of 13.96 (refer to Figure 4-14) stands for Julian day 1 hour 00. The message is not followed with a continuation line supplying a complete date. This, in combination with the I on the message code, is an indication that the message is for one of the 15-minute observations within hour 00. When it is detected that an observation has been encountered that belongs to a

```
  29 JB I19  SETUP: ENCOUNTERED END OF "JOB/RUN CARD"
   0 JB I10   TEST: SUMMARY: NO UA-EXT CARD, NULL EXTRACT
   0 JB I11   TEST: SUMMARY: NO UA-IQA CARD, NULL QA
   0 JB I12   TEST: SUMMARY: NO UA-OQA CARD, NULL MERGE
   0 JB I10   TEST: SUMMARY: NO SF-EXT CARD, NULL EXTRACT
   0 JB I11   TEST: SUMMARY: NO SF-IQA CARD, NULL QA
   0 JB I12   TEST: SUMMARY: NO SF-OQA CARD, NULL MERGE
   0 OS W15 AUTCHK: MHGT NOT IN INPUT LIST: AUDIT DISABLED
   0 OS W15 AUTCHK: NRAD NOT IN INPUT LIST: AUDIT DISABLED
   0 OS W15 AUTCHK: SE   NOT IN INPUT LIST: AUDIT DISABLED
 100 OS I58 REALCK: UB:      10.00 DT01:      13.96
 100 OS I58 REALCK: UB:      10.00 DT01:      15.40
 100 OS I58 REALCK: UB:      10.00 DT01:      12.90
 101 OS I58 REALCK: UB:      10.00 DT01:      13.57
 100 OS Q58 REALCK: UB:      10.00 DT01:      14.09
 100 OS           : ON 64/01/01/00
 101 OS Q58 REALCK: UB:      10.00 DT01:      10.05
 101 OS           : ON 64/01/01/01
 106 OS I57 REALCK: LB:      -2.00 DT01:      -2.96
 107 OS I57 REALCK: LB:      -2.00 DT01:      -3.55
 107 OS I57 REALCK: LB:      -2.00 DT01:      -3.77
 107 OS I57 REALCK: LB:      -2.00 DT01:      -3.58
 107 OS I57 REALCK: LB:      -2.00 DT01:      -4.09
 108 OS I57 REALCK: LB:      -2.00 DT01:      -4.40
 107 OS Q57 REALCK: LB:      -2.00 DT01:      -3.75
                                .
                                .
                                .

 414 OS           : ON 64/01/04/14
 415 OS I57 REALCK: LB:      -2.00 DT01:      -4.41
 416 OS I57 REALCK: LB:      -2.00 DT01:      -2.60
 417 OS I57 REALCK: LB:      -2.00 DT01:      -2.16
1128 OS I59 OSFILL: FOUND EOF FILE
```

Figure 4-14. Partial listing of error/message file generated during the processing of on-site data.

succeeding hour, the processor computes the hourly averages for the current hour. The processor then passes each hourly average through the range checks. In summary, the range check messages can result from either the within hour observations or the hourly averages, or both. Having messages from both provides a rapid means for finding suspect values within an hour, which may in turn result in suspect hourly values.

STAGE 2 PROCESSING

- Combine into one file the available on-site and NWS meteorological data files created during Stage 1 processing

- Store the data in a more compact format.

Having retrieved (extracted) the data from the original storage files and having processed these data through the quality assessment checks, the next major activity is to combine the data into one file in a compact data storage format.

The run stream input for Stage 2 processing is:

```
JB STA
JB OUT DISK REPORT.LIS
JB ERR DISK ERROR.LIS
JB FIN
UA STA
UA OQA DISK OQAUA002.DAT
UA FIN
SF STA
SF OQA DISK OQASF002.DAT
SF FIN
OS STA
OS OQA DISK OQAOS001.DAT
OS LOC 9381464  84.68W 39.07N 0
OS FIN
MR STA
MR OUT DISK MERGE1.DAT
MR EXT 63 12 31 64 01 04
MR FIN
```

No new input images are encountered in this example, however, it does illustrate for the first time the merging of data from all three pathways. The JB-pathway input should be familiar by now. It defines the general files to be used for listing the error messages and summarizing the processing results. In this example, there are data available for all three pathways, UA, SF, and OS. These data files were created during steps 2, 4, and 5 in the Stage 1 examples discussed previously.

The three data files OQAUA002.DAT, OQASF002.DAT, and OQASOS001.DAT will be combined (merged) into one data file named MERGE1.DAT. The MR OUT input image is used to provide the name of this file.

```
METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

         TODAY'S DATE AND TIME: 14-APR-88 AT 09:59:35
         INITIAL PROCESSING ON RAW METEOROLOGICAL DATA

   ***** USER INPUT PARAMETERS FOR MERGE *****

   MERGED DATA BEGIN (YR/MO/DA) 63/12/31
            AND END            64/ 1/ 4
   THE ON-SITE LATITUDE AND LONGITUDE ARE:
            LATITUDE  =        39.07N
            LONGITUDE =        84.68W


  ***** DAILY OUTPUT STATISTICS *****
            MO/DA 12/31  1/ 1  1/ 2  1/ 3  1/ 4
NWS  UPPER AIR  SDGS   2     4     4     4     4
NCDC MIXING  HEIGHTS   4     6     6     6     6
NWS SFC OBSERVATIONS   1    24    24    24    23
ON-SITE OBSERVATIONS   1    24    24    24    22

   UPPER AIR OBS. READ:   10
   SFC. OBS. READ:        96
   ON-SITE OBS. READ:     95

  ***** MERGE PROCESS COMPLETED *****
```

Figure 4-15. Second page of general report, for example where data from all three data pathways are combined (merged).

The MR EXT input is optional. Specifying start and stop dates to be associated with Stage 2 processing, this input provides a means for selecting the data to be included in the merged data file. This might be useful if one wanted to create a merged data file for a specific few days or months. If the MR EXT input is omitted, MPRM searches the OQA files on each pathway for the earliest date. This date becomes the first day of merged data. The last day of merged data acceptable is then defined as the first day plus 367. In other words, omission of the MR EXT input allows up to 368 days of data to be merged, starting from the earliest date encountered on all the input files.

The second page of the general report is shown in Figure 4-15. The time period for which merged data is created and the site latitude and longitude to be used by the regulatory dispersion models follow the standard MPRM general report header.

The daily output statistics shown in Figure 4-15 are important. Provided in this summary are the number of NWS upper air soundings, NCDC mixing heights, NWS hourly surface observations and on-site observations that were combined for each day. The are a maximum of 6 NCDC mixing heights available for each day, as Stage 2 processing combines the mixing heights for the current day with previous and next day's values. This allows development and use of interpolation routines for developing hourly estimates of mixing height. We have provided for a maximum of 24 soundings per day. As with the treatment of mixing heights, the last sounding from the previous day and the first sounding from the next day, if available, are combined with the current day's soundings, unless there are 24 values present for the current day. This allows development and use of interpolation routines for developing hourly estimates of upper air soundings. We have provided for a maximum of 24 observations of NWS surface observations and on-site observations. If an entire year's data were merged, the daily statistics summary requires five pages of printed output. The last item of the summary is the number of observations read from each input (OQA) file.

STAGE 3 PROCESSING

- Create a meteorological data file for use with a regulatory dispersion model chosen by the user.

At this point, summaries have been constructed reporting suspect and missing data values (Stage 1) and these meteorological data have been stored in a combined format (Stage 2). The goal of Stage 3 processing is to construct a meteorological data file for use with a particular dispersion model given the merged meteorological data file resulting from Stage 2 processing.

As a minimum, Stage 3 processing requires the file name of the input (merged) data file and the output file name for use by the dispersion model. There are various methodologies for generating the output meteorological data file. The RAMMET format has been selected as the default output. This is an unformatted file containing a header record and one record for each 24-hour period. The default selections for processing wind, temperature, stability category, and mixing height employ the NWS hourly surface weather observations and the NCDC twice-daily mixing height values. A full discussion of the processing assumptions is given in Section 5. In essence, processing with the default selections duplicates that performed by the RAMMET meteorological processor.

The run stream input for Stage 3 processing, with the default dispersion model, is:

```
JB STA
JB ERR DISK ERROR.LIS
JB OUT DISK REPORT.LIS
JB FIN
MP STA
MP MET DISK MERGE1.DAT  5
MP MMP DISK MPOUT.DAT
MP FIN
```

The optional controls provided for Stage 3 processing fall within one of the following three groups:

- Options for selecting the dispersion model
- Options for altering the methods employed in generating the output meteorological file
- Options for altering the reporting procedures.

Selecting Dispersion Models

Included as an option within the MP MMP input is the ability to define the dispersion model. This was discussed in Section 3. Appendix F provides specific details regarding the various output formats. If no dispersion model name is included in the MP MMP input image, the default selection is CRSTER, which produces RAMMET output.

Selecting Processing Methodologies

The MP VBL (optional) input image is provided for controlling the methodologies employed in generating the output meteorological data. The syntax is outlined as:

MP VBL ITEM ACTION XXXX

Additional input,
as required

6-character keyword
instructing processor
on how ITEM is to be
accomplished

4-character keyword
defining process
(methodology)

Table 4-1 summarizes the keywords available for ITEM and ACTION, as well as the additional input that is sometimes required.

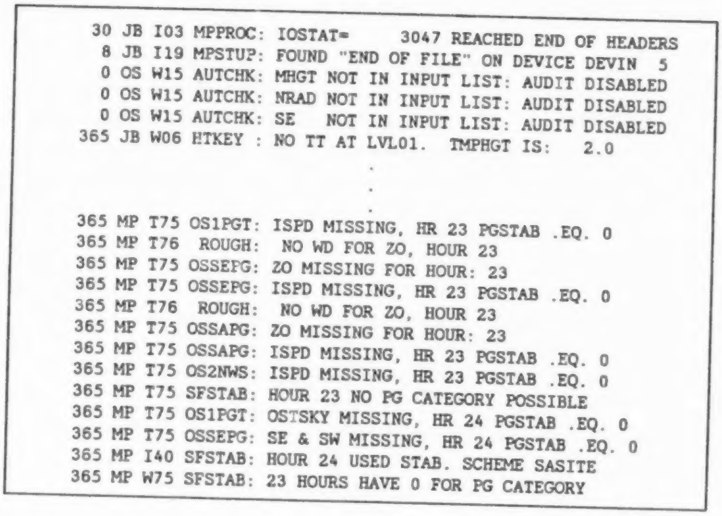
Selecting Reporting Procedures

The default reports have been described in the examples given above. The user has two means to amplify the information reported. First, the meteorological data stored in the output file for the dispersion model can be listed to the general report file. This is accomplished by use of the JB LST input. Examples of such listings are provided within Appendix D. Second, more detailed messages can be obtained within the error/message file. This is accomplished by use of the MP TRA input.

Figure 4-16 presents a partial listing of an error/message file with the MP TRA input. For Julian day 365 hour 23, it shows there was

TABLE 4-1. SUMMARY OF JB VBL INPUT KEYWORDS ITEM AND ACTION

Item	Action	Description
WIND	NWSWXX	(Default). The wind direction and speed are determined using the wind direction and speed given in the hourly NWS weather observation. As the observations are reported to the nearest 10^0, a standard set of random numbers is used, as in RAMMET, for randomizing the wind directions.
	ONSITE	Additional input is a value for STKHGT. Wind direction and speed are determined from on-site observations. Values selected are from on-site tower level nearest to value given for STKHGT.
TEMP	NWSWXX	(Default). The temperature is determined using the values given in the hourly NWS weather observation.
	ONSITE	Additional input is a value for TMPHGT. Temperature is determined from on-site observations. Values selected are from on-site tower level nearest to value given for TMPHGT.
MHGT	NWSWXX	(Default). The mixing height is determined using the NCDC twice-daily mixing height values and the stability category for the hour. The procedure is that employed in RAMMET.
	ONSITE	The mixing height given in the hourly on-site observation is used.
STAB	NWSWXX	(Default). The stability category is determined using the cloud cover, ceiling height, and wind speed (from NWS weather observations) coupled with sun's position. The procedure is that employed in RAMMET.
	ONSITE	Additional input is a value for ANEHGT. The stability category is determined using the same procedure as NWSWXX, with all data taken from the on-site observation. Wind speed values are from on-site tower level nearest to value given for ANEHGT.
	SESITE	Additional input is a value for ANEHGT. The stability category is determined using standard deviation of vertical wind direction fluctuations at tower level nearest to value given for ANEHGT.
	SASITE	Additional input is a value for ANEHGT. The stability category is determined using standard deviation of horizontal wind direction fluctuations at tower level nearest to value given for ANEHGT.
	WNDWXX	Additional input is a value given for ANEHGT. The stability category is determined using on-site wind speed from tower level nearest to ANEHGT, and NWS observations of cloud amount and ceiling height.



```
 30 JB I03 MPPROC: IOSTAT=     3047 REACHED END OF HEADERS
  8 JB I19 MPSTUP: FOUND "END OF FILE" ON DEVICE DEVIN  5
  0 OS W15 AUTCHK: MHGT NOT IN INPUT LIST: AUDIT DISABLED
  0 OS W15 AUTCHK: NRAD NOT IN INPUT LIST: AUDIT DISABLED
  0 OS W15 AUTCHK: SE   NOT IN INPUT LIST: AUDIT DISABLED
365 JB W06 HTKEY : NO TT AT LVL01.  TMPHGT IS:   2.0
                            .
                            .
                            .
365 MP T75 OS1PGT: ISPD MISSING, HR 23 PGSTAB .EQ. 0
365 MP T76  ROUGH:  NO WD FOR ZO, HOUR 23
365 MP T75 OSSEPG: ZO MISSING FOR HOUR: 23
365 MP T75 OSSEPG: ISPD MISSING, HR 23 PGSTAB .EQ. 0
365 MP T76  ROUGH:  NO WD FOR ZO, HOUR 23
365 MP T75 OSSAPG: ZO MISSING FOR HOUR: 23
365 MP T75 OSSAPG: ISPD MISSING, HR 23 PGSTAB .EQ. 0
365 MP T75 OS2NWS: ISPD MISSING, HR 23 PGSTAB .EQ. 0
365 MP T75 SFSTAB: HOUR 23 NO PG CATEGORY POSSIBLE
365 MP T75 OS1PGT: OSTSKY MISSING, HR 24 PGSTAB .EQ. 0
365 MP T75 OSSEPG: SE & SW MISSING, HR 24 PGSTAB .EQ. 0
365 MP I40 SFSTAB: HOUR 24 USED STAB. SCHEME SASITE
365 MP W75 SFSTAB: 23 HOURS HAVE 0 FOR PG CATEGORY
```

Figure 4-16. Partial listing of the error/message file, for example with trace option enabled.

insufficient data to compute a stability category. The reason why each scheme was unable to compute a stability category is listed. In order to understand the messages, the user must know which subroutines are used to compute stability category. Table 4-1 presented the keywords used to select the various processing options; Table 4-2 presents a list of the subroutines that are employed as a function of the processing options selected.

Shown in Figure 4-16 is a portion of an error/message file developed from a test case example having on-site data, in which a

```
JB VBL STAB ONSITE 10
```

image was used to define the methodology for computation of the stability categories. As explained in Section 5, an automatic search is performed in computing stability category. Hence, when subroutine OS1PGT (refer to Table 4-2) detected a missing on-site wind speed at the designated ANEHGT, subroutine OSSEPG was called to attempt computing the stability category

TABLE 4-2. SUBROUTINES EMPLOYED FOR VARIOUS PROCESSING OPTIONS

ITEM	ACTION	Subroutine
WIND	NWSWXX ONSITE	WS1NWS WS1OS
TEMP	NWSWXX ONSITE	TT1NWS TT1OS
MHGT	NWSWXX ONSITE	ZI1NWS ZI1OS
STAB	NWSWXX ONSITE SESITE SASITE WNDWXX	PGTNWS OS1PGT OSSEPG OSSAPG OS2PGT

using the SESITE option. In this manner, each of the methods employing onsite data were attempted for hour 23 to compute the stability category. For hour 24, the search ended in subroutine OSSAPG, where it was determined that sufficient data were present to employ the SASITE option for computing stability category.

SECTION 5
SCIENTIFIC NOTES

INTRODUCTION

This section provides a brief technical description of the methods employed by MPRM during processing. References to existing documents are used where possible, in lieu of duplicating lengthy technical descriptions here. In many instances, the methods are based on explicit guidance from the modeling guideline (EPA, 1986) or on-site guidance document (EPA, 1987). Hence, the following discussion is most detailed for those instances where the guidance was not particularly explicit. The section is organized by processing stage within MPRM, Stage 1 then Stage 3.

STAGE 1

Averaging Subhourly Values

The initial data file of on-site data may consist of subhourly values. The number of observations per hour is specified with the optional run stream input OS AVG, which can be used to specify the number of on-site observations expected for an hour. The default value is one observations per hour.

During the extraction processing of the on-site data, the subhourly values are averaged to produce hourly values. For most variables the hourly value is computed as the arithmetic mean. The wind speed and the wind direction are treated in a special manner, in order to properly differentiate between cases when values are missing and cases when values are present but suspect since they are below instrument threshold.

The threshold wind speed by default is 1.0 m/s, but can be redefined (but only to a lower value) through the use of the OS CLM run stream input image. Wind speeds less than threshold are given a value of one-half the threshold wind speed and the wind direction is treated as missing. The hourly wind speed is computed as an arithmetic mean. The hourly wind direction is computed according to the method given in Section 6.1 of the on-site guidance document (EPA, 1987) to properly account for the 0-360 degree crossover.

For all standard deviations of wind fluctuations (both speed and direction), hourly values are computed as the root-mean-square of the subhourly values, following the on-site guidance document (EPA, 1987).

Quality Assessment

During Stage 1 processing, quality assessment is performed on each pathway by comparing data values to the upper and lower bounds defined for each variable. Default quality assessment bounds are defined in Appendix C, but these values can be overridden by the user with the CHK input image. The endpoints of the interval, i.e., the boundary values, are either included as acceptable data or excluded as questionable data according to the Range Check Switch field. This parameter can also be changed with the CHK input image. The default value of the Range Check Switch for each variable is also defined in Appendix C.

Prior to performing the quality assessment on upper air soundings, the processor recomputes the heights reported in the soundings using the hypsometric formula. If the surface height is missing, the heights are not recomputed.

Because the upper air soundings contain multiple levels of data, vertical gradients of several variables can also be checked. This poses a question of how to report the audit results as there are a variable number of levels in a sounding and the heights of the levels differ from sounding to sounding. Our solution was to define ten height categories into which we accumulate the results. The categories are defined as the surface (the first level alone), eight height intervals, and all heights above the uppermost interval. The interval thickness is defined to be 500 meters. The eight height intervals are, therefore, 0 - 500, 500 - 1000, ..., 3500 - 4000 meters. The lower bound is excluded and the upper bound is included in each interval. All heights above 4000 meters are placed in the last category. The interval thickness is controlled by the variable UAINC, which is specified in a DATA statement and cannot be changed without changing the value in the DATA statement, recompiling and relinking the processor.

The gradient of temperature, or lapse rate, between two levels in the upper air data is checked against an upper and lower bound. The default maximum value is 5 ^{0}C/100 meters and the default minimum is -2 ^{0}C/100 meters. Note that these values are expressed as integer values per 100 meters and any changes to the default values, via UA CHK input image, must also be expressed in degrees C/100 meters. The variable name for use with CHK to alter the range check parameters for the temperature lapse rate is UALR.

Wind velocity has two components: speed and direction. The vertical gradient of the wind, or shear, can be expressed either as a vector shear in which both speed and direction are combined to yield one shear value, or speed and direction separately. The wind speed and direction shear are expressed separately in MPRM. The default maximum wind speed shear is 5 (m/s)/100 meters. Because the absolute difference of the speed is considered, i.e. the computation is independent of which level has the higher wind speed, the default minimum speed shear is 0 (m/s)/100 meters. The variable name for use with CHK to alter the range check parameters for the wind speed shear is UASS. The default maximum wind direction shear is 90 degrees/100 meters and the minimum is 0 degrees/100 meters. The directional shear is independent of which way the wind changes with height (i.e., clockwise or counterclockwise). The variable name for use with CHK to alter the range check parameters for the wind direction shear is UADS.

The vertical gradient of dew-point temperature is treated a little differently than the lapse rate and wind shear. Three consecutive values are required for this evaluation. An estimate from the line drawn between the upper and lower points is made at the height of the middle point. The absolute difference between the estimate and the actual dew-point is divided by the height difference between the upper and lower points. This value is compared to the upper and lower bounds defined by UADD. The default upper and lower bounds are 2 ^{0}C/100 meters and 0 ^{0}C/100 meters, respectively.

The violations for the lapse rate and shear are tallied into the height category containing the upper height, whereas the dew-point violations are tallied into the height category containing the middle point. Therefore, if none of the data required to perform the gradient calculations are missing, then there are (N-1) checks on lapse rate and shear and (N-2) checks on dew-point, where N represents the number of levels in a sounding.

Upper Air Data Modification

During the extraction of upper air soundings in Stage 1 processing, the MPRM processor can check the data for possible errors in each sounding and perform certain automatic data modifications. These actions are an option controlled by the user with the UA OFF input image. If this image is omitted, then the soundings are checked for automatic substitution. If this image is present, then the soundings are NOT checked for modification. The syntax of this input image is simply UA OFF. No other fields are required.

Data modifications can occur for:

- The sign of temperature above 1000 meters
- The lapse rate between two levels
- A mandatory level within 1 percent of a significant level
- A zero wind speed with a corresponding non-zero wind direction
- Missing values of dry bulb temperature and dew-point temperature
- Height above mean sea level.

There is no way to turn on and off individual actions. Either all the actions are performed or none of them are performed.

The warning messages that are written if the data are modified include the date and time. The format is YYMMDD/HH where YY = 2-digit year, MM = month (1-12), DD = day (1-31) and HH = hour (1-24).

Temperature above 1000 meters

For heights above 1000 meters above ground level (AGL), temperatures greater than 10 °C are checked to insure they have the correct sign. The sign of the temperature immediately below the level in question is checked. If the sign is negative, then the sign of the temperature at the level in question is changed to negative; if the sign is positive or if the temperature is missing, then no action is taken. This action was introduced to reduce the number of sign errors that occur in the TD-5600 format data. The primary emphasis is on levels away from the surface where it is obvious that the signs were in error. No attempt is made here to correct the data near the surface. Checks of temperatures fluctuating around 0 °C are also avoided, where the temperature can switch signs from one level to the next, by only considering temperatures greater than 10 °C.

Lapse rate

If the temperature lapse rate between two levels is superadiabatic, i.e., less than -0.0098 °C/meter, and the lower level temperature is greater than 0 °C, the sign of the lower level temperature is changed. This sign change is not performed if it would create a temperature inversion greater than the maximum defined with the keyword UALR, i.e., the lapse rate upper bound for quality assessment (see Appendix C for default value).

Mandatory levels

If a mandatory sounding level is within one percent of a significant level (with respect to pressure) then the mandatory level is deleted. Because the mandatory levels were originally computed from the data at the significant levels, there is no loss of information in the sounding.

Deleting mandatory levels occurs after the data are retrieved from tape, which results in reducing the number of levels in a sounding. If the maximum number of levels is retrieved, then this process will produce a sounding with fewer than the maximum number of levels, i.e., the processor does not return to the tape to retrieve additional levels. At present the maximum number of levels that can be retrieved is 20.

Calm wind conditions

The wind speed and direction at each level are checked to insure that there are no levels with a zero wind speed and a non-zero wind direction. If one is found, the wind direction is set to zero to represent calm conditions.

Missing dry bulb and dew-point temperatures

If temperature or dew-point at a level is represented by a missing value indicator, then an estimate for the missing observation is made by linearly interpolating to the level in question. The data from the level immediately below and the nearest valid data from above the level in question are used. If data that are required for the interpolation are also missing, then no interpolation is performed.

Sounding heights

The sounding heights on magnetic tape are stored as meters above mean sea level. With the sounding modification actions enabled, the heights are converted to meters above ground level. The first level in a sounding is for the surface. The height at this level is subtracted from all levels including the surface, so that the heights start at 0 meters. If the height is missing at the surface, then a value of zero is assumed in performing the subtractions.

STAGE 3

Wind

The default method for handling wind data by MPRM is to use NWS surface observations. The data are hourly and result from observations made at a single level. No input is required for implementation. If the data are missing, then a missing value indicator is written to the output file, and a message is inserted in the error/message file to warn the user that this has occurred.

Calm winds are handled somewhat differently for dispersion models requiring hourly specification of the meteorological conditions versus those requiring STAR output. When processing NWS surface observations for hourly output, if the wind speed is less than 1 m/s, then the speed is set to 1 m/s and the wind direction is set equal to the last valid wind direction value. When processing on-site observations for hourly output, if the wind speed is less than threshold (OSCALM), then the speed is set to 1 m/s and the wind direction is set equal to the last valid wind direction value. If the on-site speed is less than 1 m/s but greater than or equal to threshold, the speed is set to 1 m/s. For those models requiring STAR output, the occurrences of calm winds are distributed within the lowest wind speed classes in accordance with the directional distribution of non-calm observations within these classes.

For on-site data during Stage 1 processing, the user specified the data available and the format of the data (through the OS MAP input), which may have included several levels of wind data. The current list of dispersion models accommodated by MPRM process wind at only one level for use primarily in estimates of plume rise and transport. The current guidance recommends use of wind data at the height of the stack top. Hence, to implement use of on-site data in defining the the wind, the user must identify the measurement level to be used in defining the wind. The value given on the MP VBL input is stored within MPRM in a variable called STKHGT. MPRM determines the measurement level closest to the value of STKHGT. This measurement level is then used in all determinations of wind. In defining the measurement level, MPRM interrogates the OS MAP input images to insure that wind data are available at the tower level nearest to the value given for STKHGT. Processing is stopped if the data map of on-site variables indicates that no wind data are available on the tower level nearest to the value given for STKHGT. Since any value greater than zero for STKHGT is allowed, the user can specify the level that is best for the given dispersion analysis. This may or may not be the level nearest to the actual height of the stack being modeled, as the data may not be representative for one reason or another, or more likely, the data may not be sufficiently complete at all levels to satisfy the guidance recommendations of a 90 percent data capture rate.

Consider the case of on-site wind data being available at 10, 60 and 100 m on a meteorological mast, and the stack height to be modeled is 300 m. The user could include as input during Stage 3 processing:

```
MP VBL WIND ONSITE 300
```

MPRM would then process the 100 m wind data, the level closest to 300 m, for generating the modeling output file. What would happen if the 100 m data were only available during a small portion of the period to be analyzed? Perhaps, the instruments at 100 m were damaged and replacement was delayed. Then the input could be modified to force MPRM to select the wind data at a lower level where the observation record is more complete as:

```
MP VBL WIND ONSITE 60.
```

Temperature

The default method for processing temperature data by MPRM is to use NWS surface observations. The data are hourly and result from observations made at a single level. No input is required for implementation. If the data are missing, then a missing value indicator is written to the output file, and a message is inserted in the error/message file to warn the user that this has occurred.

For on-site data during Stage 1 processing, the user has specified the data available and the format of the data (through the OS MAP input), which may have included several levels of temperature. The current list of dispersion models accommodated by MPRM only process temperatures at one level. To implement use of on-site data in defining the temperature, the user must identify the measurement level to be used within the on-site observations having temperature data. The value given on the MP VBL input is stored within MPRM in a variable called TMPHGT. MPRM determines the measurement level closest to the value of TMPHGT. This measurement level is then used in all determinations of temperature. In defining the measurement level, MPRM interrogates the OS MAP input to insure that temperature data are available at the tower level nearest to the value given for TMPHGT. Processing is stopped if the data map of on-site variables indicates that no data are available on the tower level nearest to the value given for TMPHGT.

No explicit height is recommended within the guidance on processing on-site meteorological observations for use in regulatory dispersion models. Given the usage made of temperatures within the dispersion models currently accepted for regulatory use, we believe the temperature should be representative of what is typically reported within the NWS hourly observations, which is a near-surface value.

As with defining the value of STKHGT for use in specifying the wind, any value greater than zero for TMPHGT is allowed. Thus, the user can specify the level that is best for the given dispersion analysis.

Consider the case of on-site temperature data being available at 10 and 100 m on a meteorological mast. The user could include as input during Stage 3 processing:

```
MP VBL TEMP ONSITE 2
```

MPRM would then process the 10 m temperature data, the level closest to 2 m, for generating the modeling output file.

<u>Stability Category</u>

There are five options in MPRM for processing data to obtain Pasquill stability categories. The default option is to use the method of Turner (1964) as implemented within RAMMET. This method employs wind speed, cloud cover and ceiling height data from a nearby NWS surface station. Opaque sky cover is preferred, but total sky cover may also be employed. This method is described in the guidance document on processing on-site meteorological observations for use in regulatory applications (EPA, 1987).

The remaining four methods require at least some on-site data. The methods, in order of preference, are:

1. Turner's (1964) method using on-site data, which include sky cover, ceiling height and near-surface (~10 m) wind speed data

2. σ_e and wind speed (u) from on-site data (σ_e may be determined either from direct observation of elevation angle fluctuations, or from the transformation $\sigma_e \approx \sigma_w/u$)

3. σ_a and wind speed from on-site data

4. Turner's (1964) method using on-site wind speed data coupled with sky cover and ceiling height observations from a nearby NWS station.

These methods are described more fully in the guidance document on processing on-site meteorological observations (EPA, 1987). The wind speed and turbulence data used in stability category determinations should be taken from a near-surface level, nominally 10 meters.

The user identifies the measurement level to be used in the on-site observations within the MP VBL input. The value given on the MP VBL input is stored within MPRM in a variable called ANEHGT. MPRM determines the measurement level closest to the value of ANEHGT. This measurement level is then used in all determinations of stability categories for definition of wind speed and turbulence values.

All four of the on-site methods are acceptable, according to the modeling guidance. If the data necessary for the method chosen by the user are missing, MPRM has been designed to cycle through the methods, in the order of preference. For example, the user may specify the σ_a method (method 3) as the primary method for stability category determination. If σ_a data are missing, MPRM will first attempt to determine stability from method (1) above, and if the requisite data are missing for method (1), then MPRM will attempt to employ method (2), and if need be method (4). If the stability category can not be determined by any of the four methods, then it is encoded as missing for that hour. MPRM maintains a count of the number of hours of data processed for each of the methods and includes this information in the general report file. Specific instances of stability substitutions can be traced through the error/message file, by including the JB TRA input image during Stage 3 processing. Note, since all four on-site methods require near-surface wind speed data, if the wind speed is missing, then the stability category will be considered missing. Furthermore, whenever the σ_e method is attempted, the transformation using σ_w is automatically invoked if MPRM detects that σ_e is missing for the hour.

The default method for stability category determination, which relies solely on NWS hourly observations, is excluded from use if the primary method of choice is one of the methods that employs on-site data. Since the default method and method (4) differ only in location of wind speed data, use of the default methodology, when on-site data methods are the primary methods of choice, is equivalent to data substitution of off-site wind speed data for missing on-site wind speed data. As mentioned earlier in the first section, we have avoided automatic data substitutions until there is a clear consensus as to how best to implement such procedures.

Mixing Height

The default method for processing mixing height is to use the interpolation scheme employed in the RAMMET meteorological processor, which uses the twice-daily mixing heights from the nearest NWS upper air observation site, coupled with the stability category determined for the hour. This method is described in more detail in the RAM model user's guide (Catalano et al., 1987).

The user may also designate the on-site mixing height to be employed. MPRM simply uses the value for the hour given in the on-site observation.

Roughness Length

MPRM allows the user to specify a direction dependent surface roughness length for up to twelve wind direction sectors. As discussed earlier, the roughness length values can be varied by month of year as well as wind direction sector. The roughness length values are incorporated into the header information of the OQA-file created while processing the on-site data. These header records are in turn incorporated into the header information of the combined (merged) file created during Stage 2 processing.

The roughness length is used in Stage 3 processing to adjust the σ_e and σ_a stability category boundaries, as discussed in the modeling guideline (EPA, 1986) and the on-site guidance document (EPA, 1987). When an attempt is made to determine the stability category for a given hour using one of these on-site methodologies, the wind direction at the lowest level (above 2 m) on the tower is used to define the wind direction sector from which the wind is blowing. The roughness length is then determined given the wind direction sector and the month of the year.

Guidance on how one might determine a representative value for the roughness length for a given site can be found in the on-site guidance document (EPA, 1987).

Output Formats

The output format of the meteorological file generated during Stage 3 processing can be characterized into two classes, short term (hourly) and long term (seasonal or annual). The hourly formats available are the RAMMET format, used by several models, the CALINE-3 format, and the RTDM format. The long term formats are joint frequency functions also know known as STability ARrays (STAR). The STAR formats for the ISCLT and VALLEY models employ six stability categories (A, B, C, D, E, F). The STAR formats for the CDM-2.0 model employ six stability categories (A, B, C, D-day, D-night, E-F). Appendix F describes in more detail the various output formats.

SECTION 6
PROGRAM NOTES

INTRODUCTION

The MPRM processor is designed and coded to allow it to run on most operating systems. The processor is coded entirely in FORTRAN. Although this increases the amount of time for I/O operations (for example, reading data from magnetic tape is greatly increased), the user does not have to make major modifications to the code to create an executable processor. This section describes briefly the processor design, system dependent source code, creating executable code from the source code and some miscellaneous, but important, processor notes.

FORTRAN COMPATIBILITY AND PROCESSOR DESIGN

To retain portability, the MPRM processor was coded using American National Standards Institute (ANSI) FORTRAN X3.9-1978 or, as it is more commonly known, FORTRAN-77. Every attempt was made to use only the standard FORTRAN available without additional computer specific features (extensions). However, there are a few subroutines where these extensions became necessary and they are described below.

The MPRM processor was designed to be used on the most limiting machine, in terms of memory, the personal computer. To this end, the processor is composed of units that are easily overlayed when linking the processor with the FORTRAN languages available for personal computer systems. The system was compiled and tested on a PC (compatible with the IBM PC-XT) that has 640 Kb of main memory using Ryan-McFarland Corporation's RM/FORTRAN, version 2.10. The program processing for Stages

1 and 2 is shown in Figure 6-1. All operations involving the setup and writing summaries are separate from pathway processing, which are in themselves separate from each other.

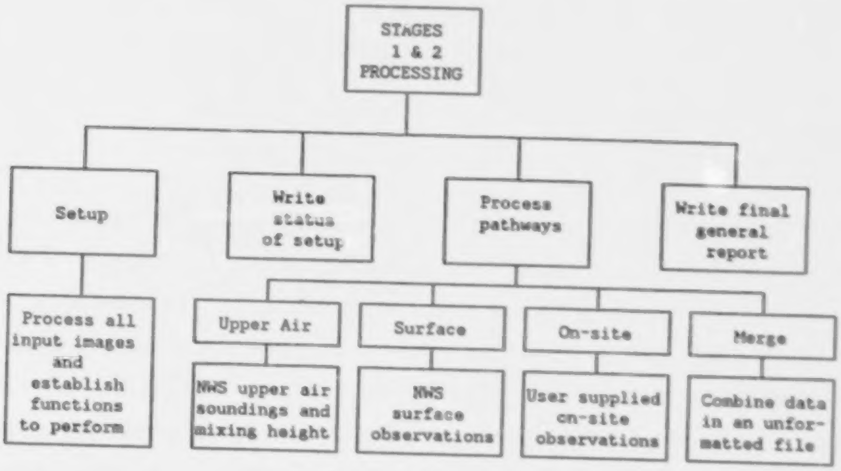

STAGES 1 & 2 PROCESSING
Setup
Write status of setup
Process pathways
Write final general report
Process all input images and establish functions to perform
Upper Air
Surface
On-site
Merge
NWS upper air soundings and mixing height
NWS surface observations
User supplied on-site observations
Combine data in an unformatted file

Figure 6-1. Flow diagram of MPRM Stage 1 and Stage 2 processing.

SYSTEM SPECIFIC SOURCE CODE

Nearly all the subroutines in the MPRM processor contain statements to include named COMMON blocks. The named COMMON blocks were divided into 12 separate files. The method for incorporating these statements into the source code varies according to the compiler in use, but all use some form of the nonstandard INCLUDE statement. These statements appear as extensions to VAX-11 FORTRAN (version 3.0), IBM VS FORTRAN (version 2), RM/FORTRAN (version 2.10) and Microsoft FORTRAN (version 4.0). The syntax for each of these is shown below. The punctuation is required where shown except for the left and right bracket, which indicates an optional parameter. In the accompanying examples, the assumption is made that the INCLUDE files are in the same subdirectory or partitioned data set as the main programs and subroutines that use them.

VAX-11 FORTRAN

INCLUDE 'filename[/LIST]', where filename is any valid VAX file specification and /LIST, which is optional, indicates that the statements are to be listed in the compilation source listing. If /LIST is omitted then no listing of the included files appears in the compilation listing.

Example: `INCLUDE 'MAIN1.FOR/LIST'`

IBM VS FORTRAN

INCLUDE (name) [n], where name is the member name in the partitioned data set and n is a value used to decide whether or not to include the file during compilation. This parameter can be omitted, in which case the file is included, or can take on a value from 1 to 255. If the value of n appears in the CI compile option, then the file is included, otherwise it is omitted. This is not the simple list or no list option, rather it includes or excludes the named member in the compilation.

Example: `INCLUDE (MAIN1)`

RM/FORTRAN, version 2.10

INCLUDE 'filename', where filename is any valid DOS file specification.

Example: `INCLUDE 'MAIN1.FOR'`

Microsoft FORTRAN, version 4.0

$INCLUDE:'filename' where filename is a valid DOS file specification.

Example: `$INCLUDE:'MAIN1.FOR'`

There are several other system dependent statements that have been placed in separate subroutines to expedite the transfer of source code between systems. The first group of subroutines are concerned with the OPEN statements for disk files and magnetic tapes. The second group contains a subroutine for character conversion and a subroutine to return the system date and time.

The first group of subroutines is retained in a file named SETUPVX.FOR for VAX applications, SETUPPC.FOR for PC applications and SETUPIBM.FOR for IBM mainframe applications. These control the opening of disk files (subroutine FLOPEN) and magnetic tapes (subroutine TPOPEN) and perform operations on ASCII and EBCDIC positional codes.

The second group is retained in LIBVX.FOR (for VAX), LIBPC.FOR (for PC) and LIBIBM.FOR (for IBM). The character conversion subroutine (CHCONV) is used in converting EBCDIC characters on magnetic tape to ASCII characters. It uses the VAX octal representation of characters. This conversion is only required on the VAX. Because magnetic tape drives are not normally available on personal computers and because the IBM operates with EBCDIC, a dummy subroutine has been provided for these systems.

Also included in the second group is a subroutine (DATER) to return the operating system date and time. The system routines used to perform this function vary, so the correct calls to the system routines are provided.

Within the second group is a subroutine for use on IBM systems. The routine accesses an extended error handling routine. This routine allows uninterrupted processing of data files typically available from NCDC. This is discussed in more detail under "Processor Notes". Dummy subroutines are provided for VAX and PC applications.

CREATING EXECUTABLE CODE FROM THE SOURCE CODE

On a Personal Computer

MPRM requires nearly 540 Kb of RAM for Stage 1 and 2 processing and 500 Kb to for Stage 3 processing. For testing, the source code was compiled using the /N option available in RM/FORTRAN. This option uses the math co-processor (8087 or 80287) if present, but will run on a system that does not contain the co-processor.

For Stage 1 and 2 processing, the following files are needed:

Main program and subroutines:

```
     STAGE1N2.FOR        OSFILE.FOR       SETUP.FOR        SFFILE.FOR
     SETUPPC.FOR         UAFILE.FOR       OSSETUP.FOR      MERGE.FOR
     COMPLETE.FOR        HEADER.FOR       LIBFILE.FOR      LIBPC.FOR
```

Files for INCLUDE statements:

```
     MAIN1.FOR           SF1.FOR          MAIN2.FOR        SF2.FOR
     CS1.FOR             UA1.FOR          OS2.FOR          UA2.FOR
     MASTER.FOR          WORK1.FOR
```

Only the main program and subroutines have to be compiled. The source code in the INCLUDE files is automatically included in the compilation. An object file library should be created using OSSETUP.OBJ, COMPLETE.OBJ, HEADER.OBJ, LIBFILE.OBJ and LIBPC.OBJ. This library is also used in creating the Stage 3 executable code. It is recommended that an overlay structure be used. An overlay is a subprogram that resides on disk until needed. When an overlay is loaded into memory, it replaces any previous overlay. The Stage 1 and 2 executable (STAGE1N2.EXE) should be linked with the following overlay structure:

Main program and subroutines:

STAGE1N2.OBJ and object file library	always memory resident
SETUP.OBJ, SETUPPC.OBJ	overlay 1
OSFILE.OBJ	overlay 2
SFFILE.OBJ	overlay 3
UAFILE.OBJ	overlay 4
MERGE.OBJ	overlay 5

The five overlays are independent of each other and can be linked in any order. Consult your FORTRAN manual for additional information on overlaying files.

The Stage 3 requires the following files:

Main program and subroutines:

- STAGE3.FOR
- SETUPPC.FOR
- HEADER.FOR
- MP2XFOR.FOR
- MP4XFOR.FOR
- SETUP.FOR
- OSSETUP.FOR
- MP3XFOR.FOR
- COMPLETE.FOR

Files for INCLUDE statements:

- MAIN1.FOR
- SF2.FOR
- UA2.FOR
- SF1.FOR
- OS1.FOR
- MASTER.FOR
- MP1.FOR
- UA1.FOR
- WORK1.FOR
- MAIN2.FOR
- OS2.FOR

The Stage 3 executable (STAGE3.EXE) should be linked with the following overlay structure:

Main program and subroutines:

STAGE3.OBJ and object file library	always memory resident
SETUP.OBJ, SETUPPC.OBJ, MP2XFOR.OBJ	overlay 1
MP3XFOR.OBJ, MP4XFOR.OBJ	overlay 2

Figure 6-2 summarizes the structure of the processor after the executable code has been created for the three stages of processing.

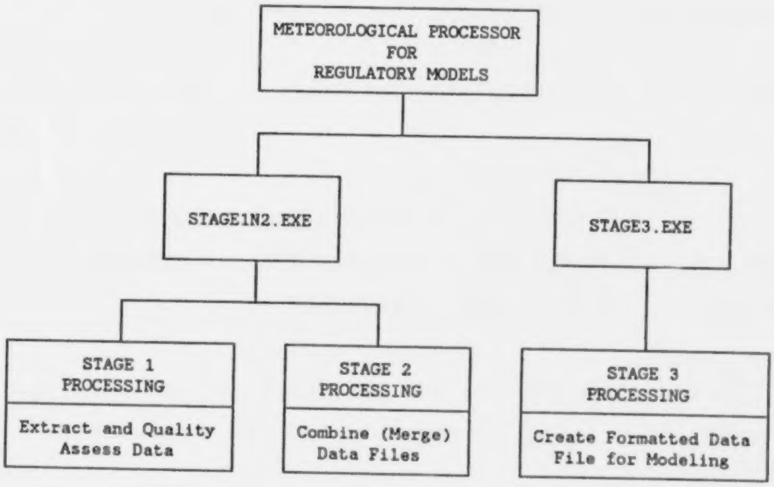

METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS
STAGE1N2.EXE
STAGE3.EXE
STAGE 1 PROCESSING
Extract and Quality Assess Data
STAGE 2 PROCESSING
Combine (Merge) Data Files
STAGE 3 PROCESSING
Create Formatted Data File for Modeling

Figure 6-2. Overview of processing stages within MPRM.

On a VAX

The following instructions assume that each file is separate and all files reside in the same directory.

For Stage 1 and 2 processing, the following source code files are used:

STAGE1N2.FOR SETUP.FOR SETUPVX.FOR OSSETUP.FOR
COMPLETE.FOR HEADER.FOR OSFILE.FOR SFFILE.FOR
UAFILE.FOR MERGE.FOR LIBFILE.FOR LIBVX.FOR

The INCLUDE files are the same as for the PC. Because the VAX is a virtual memory machine, the memory restrictions imposed by a personal computer are not applicable on the VAX. Therefore, each file can be compiled separately (we suggest using the /OPTIMIZE and /CHECKS=ALL options) and an executable code created with a simple LINK statement, e.g.,

```
LINK STAGE1N2, SETUP, ..., LIBFILE, LIBVX.
```

Note that, unlike the PC, no object file library is created with this method.

In creating the executable code for Stage 3, the same source code used are:

STAGE3.FOR
COMPLETE.FOR
MP4XFOR.FOR
SETUP.FOR
HEADER.FOR
LIBFILE.FOR
SETUPVX.FOR
MP2XFOR.FOR
LIBVX.FOR
OSSETUP.FOR
MP3XFOR.FOR

The INCLUDE files used for the PC are also used for the VAX. Again each file is compiled separately and the executable code is created with a simple LINK statement.

<u>On an IBM</u>

The following instructions assume that each file resides as a member in one partitioned data set. A partitioned data set allocated with a fixed length (80 bytes), blocked record format and a block size of 3120 bytes required 51 tracks on the IBM 3090 at the National Computer Center (NCC) in Research Triangle Park, NC.

The same source code files used for the VAX are used on the IBM except that SETUPIBM and LIBIBM replace SETUPVX.FOR and LIBVX.FOR, respectively (note that SETUPIBM and LIBIBM are referenced as members of a partitioned data set). The INCLUDE files are the same as for the PC and VAX. A load module is created in one step (the code compiled and link edited) by concatenating the data set members in one DD statement and placed in a partitioned data set separate from the source code. This procedure is applicable to both STAGE1N2 and STAGE3. Additional considerations for running MPRM on the IBM can be found later in this section.

Checklist

The source code, as delivered, is ready for use on a PC. Several changes to the source code may be required prior to running MPRM on another system. The following is a list of items to assist the user in preparing MPRM for another computer system.

- Check the INCLUDE syntax (discussed earlier in this section)
- Check how end-of-file conditions are handled and set the logical variable BACK40 accordingly (discussed later in this section or see comments in MASTER.FOR)
- Verify that the standard default input and output logical device numbers are 5 and 6, respectively (discussed later in this section)
- If upper air soundings are to be extracted from the TD-5600 variable block format, verify that the variable controlling the number of bytes to skip at the beginning of each block (UABSIZ) is set correctly (see discussion in this section or see comments in MASTER.FOR)

PROCESSOR NOTES

Standard Input and Output Devices

The MPRM processor uses logical unit 5 as the standard input (console or keyboard) and unit 6 as the standard output (screen) devices. These are defined in DATA statements as variables DEVIN and DEVIO, respectively, in the master common blocks in files MASTER.FOR. These unit numbers can easily be changed to accommodate other operating system's default values.

End-of-file Conditions

Because end-of-files are handled differently on the PC than on the VAX, a logical variable was defined to either backspace or not backspace when the end-of-file was encountered. This logical variable, BACK40, is defined in MASTER.FOR at the end of the file. For the VAX, BACK40 should be .FALSE. and for personal computer and IBM applications, BACK40 should be .TRUE..

File Header Records

The MPRM processor writes pathway information as a series of records at the top of output files used during data extraction, data quality assessment and merging. These records, referred to as header records, are a maximum of 83 characters in length. The first 3 characters have special meaning to MPRM. If the additional informational header records are added to the top of these files, the first character should be an asterisk, *, followed by 2 blank characters. The 2 characters following the asterisk are reserved for use exclusively by MPRM and should not be altered, except as altered by MPRM during processing. The only restriction currently imposed on the last 80 characters of the header records is that characters should be limited to parenthesis, plus and minus sign, comma, period, numbers and letters (upper or lower case).

Upper Air Sounding Format

Another variable whose value may require changing has to do with extracting upper air soundings from magnetic tape. The variable, UABSIZ, is either a 0 as currently set or 4. This variable controls the number of bytes to skip at the beginning of each physical block of data on the tape and pertains only to the TD-5600 variable blocked format available from

NCDC. If the tape pre-dates the introduction of the newer TD-6200 series formats, then UABSIZ must be set to 4. If the tape was ordered after the introduction of the TD-6200 series format, then UABSIZ must be set to 0.

Mounting Magnetic Tapes on the VAX

On mainframe systems such as the VAX, tape drives are usually available. National Weather Service upper air soundings and surface data can be retrieved from magnetic tape using the MPRM processor. Prior to running the processor, however, the tape must be mounted on a tape drive. One possible sequence of VAX command (DCL) statements to do this for the upper air soundings is shown below. Variations on this DCL may be available or necessary.

```
$ ! ALLOCATE THE TAPE DRIVE
$ !
$ ALLOCATE $TAPE1
$ !
$ ! SEND A MESSAGE TO THE OPERATOR WHO MOUNTS
$ ! THE TAPE (QUOTES REQUIRED)
$ !
$ REQUEST/TO=TAPES 'your message'
$ !
$ MOUNT/FOREIGN/NOWRITE/DENSITY=1600/BLOCKSIZE=8000 -
      /NOLABEL $TAPE1 B20101 TAPE10
```

The ALLOCATE command allocates a tape drive with the device name $TAPE1. The REQUEST command, which is optional, sends a message to the tape operator informing him a request for a tape to be mounted is forthcoming.

The MOUNT statement sets several parameters, but the most important piece of information in this command is the last parameter, TAPE10. This field is the logical name associated with the tape and must match the name given in the run stream on the IN1 image. Likewise, when NWS surface observations or mixing height estimates are to be extracted from tape, the logical name of the tape and the tape name parameter on the IN2 image must match (see the table in Appendix B on Defining Tape File Names, Keywords IN1 and IN2, parameter Tapename).

The remaining parameters in the MOUNT statement indicate that the tape is not a VAX system tape (FOREIGN and NOLABEL) and not to write to the tape (NOWRITE), that the data are stored at 1600 bpi (DENSITY) and the maximum block size is 8000 bytes (BLOCKSIZE).

Running MPRM on an IBM mainframe

MPRM was tested on an IBM 3090-200 running under Release 3.8 of OS/VS2 MVS. A discussion on creating the executable code on the IBM appears earlier in this section. Some of the information appearing here may be too restrictive or inefficient, but accurately describes how MPRM was tested on the IBM. Suggestions on improving the use of the IBM should be sent to the authors.

If MPRM requires a magnetic tape as input (e.g., NWS surface weather observations), a scanning utility should be used to determine the correct attributes of the tape, such as the maximum size of the blocks, if a label exists, fixed or variable length records. This insures the correct job control language (JCL) when running MPRM.

For MPRM to work properly on the IBM, the following guidelines should be observed.

1) When specifying disk file names in a run stream, the run stream file name must match the 1-7 character DD statement name in the JCL. This statement defines the data set name where the input/output data are read/written.

2) When allocating space for a new data set, whether through the JCL or TSO or ISPF, allocate sufficient space to store the entire data set. Data set attributes for several data types are shown below. Other attributes can be inferred from Table 6-2b.

TABLE 6-1. DATA SET ATTRIBUTES ON THE IBM FOR THE FOUR DAY TEST CASE.

Data	Organization	Record Format	Block Size (bytes)	Record Length (bytes)	Storage Required
1 year NWS hourly surface data, CD-144 format	PS	FB	3120	80	18 tracks
1 year NCDC mixing heights, 44 bytes/record	PS	FB	3120	44	1 track
1 year merged mixing heights and surface observations	PS	VBS	6604	2200	5 tracks
1 year RAMMET format	PS	FBS	6000	1000	1 track
4 days on-site, 4 observations/hour, 3 records/observation	PS	FB	85	85	15 tracks
Error message file*	PS	FB	8000	80	3 tracks
General report file*	PS	FB	7920	132	3 tracks

PS = physical sequential
FB = fixed length, blocked
VBS = variable length, blocked, spanned
FBS = fixed length, blocked, spanned
* storage requirements depend on options used.

3) MPRM makes use of a temporary file attached to logical unit (device) 70. The DD statement <u>name TEMP70 must be used</u>. Because the data set is small and temporary, a suggested DD statement and subparameters are

```
//TEMP70  DD  DSN=prefix.data_set_name
//            DISP=(NEW,DELETE),
//            DCB=(DSORG=PS,RECFM=FB,LRECL=100,BLKSIZE=100),
//            SPACE=(TRK,(1,1))
```

The data set name (DSN) is completely arbitrary and can be any name the user chooses. For the IBM 3090 at NCC, the prefix is the concatenation of the user ID and account ID. The important name is the DD statement name - it must be TEMP70.

4) The default DD statement name FT05F001 connects the input images in the run stream to the load module and FT06F001 connects the output to the printer. If the default input and output logical unit numbers (5 and 6, respectively) are changed in MPRM, then the DD statement names must also change.

5) To extract data from magnetic tape, the JCL must reflect the 'unknown' nature of the data. Because the same subroutine, and, therefore, FORTRAN READ statement, is used to read all magnetic tape formats, the record format should be specified as U (for undefined length records) and the block size (BLKSIZE) should be specified as the largest block, in bytes, in the file on tape. This is where the tape scanning utility is most helpful. An example DD statement for extracting upper air soundings in an EBCDIC TD-5600VB format (note: do not confuse the VB here with IBM's variable length, blocked record format - the two are different) is

```
//TAPE10  DD  DSN=prefix.data_set_name
//            DISP=(OLD),
//            DCB=(RECFM=U,BLKSIZE=6000),
//            UNIT=(TAPE,,DEFER)
//            LABEL=(1,NL,EXPDT=98000)
```

The DD statement name, TAPE10 in this example, must match the tape file name in the run stream defined on the UA IN1 input image (see the table in Appendix B on Defining Tape File Names).

6) ASCII tapes require additional information to be added to the DD statement. The subparameter OPTCD=Q should be added to the DCB

parameter. This informs the computer to expect ASCII characters. NOTE: Some systems may restrict the maximum number of bytes per block (the BLKSIZE). Consult your IBM manuals or user support services before proceeding with an ASCII tape.

7) The IBM extended error-handling subroutine ERRSET is employed to provide uninterupted processing of magnetic tapes and the merged data file.

Because the length of a block of data on tape is not constant from one format to another (e.g., TD-5600 and CD-144) and possibly within in a format (e.g., TD-5600VB), each read of the tape causes a non-fatal error condition (number 212) on the IBM. The default number of such errors is 10 and there are normally several hundred blocks of data on one tape. The subroutine ERRSET is called to increment by one the number of allowable errors prior to each time the tape is read. This allows the tape to be read but MPRM will stop if the same error condition occurs elsewhere in the processing.

When processing the unformatted merged data, MPRM distinguishes between the file header records and the data by the asterisk (*) in column 1 of the headers. The headers are read as character strings with a check that an asterisk is found in column 1. When the first record of data are encountered, an error condition occurs. MPRM responds to this by branching to the section of code that backspaces on the merged data file and begins reading the integer and real data. The IBM issues a non-fatal error message (for error 213) and increments its internal error counter. The default number of 213 errors is 10. Actions identical to those taken for 212 errors are employed. However, in any one run of Stage 3, the error for this particular reason can occur only twice. MPRM will stop for any other reason if error 213 is encountered.

8) The DD statement name for the data set of random numbers used during Stage 3 processing for RAMMET processing must be IRND.

Scan Reports

If data to be extracted from magnetic tape are not found on the tape, then a short report of the tape contents is written to the end of the error/message file. An example of the report is shown in Figure D-4 in Appendix D. A separate line is written whenever a station identification number changes or a year changes. To speed the search for data, only the first upper air sounding, mixing height or surface observation is read from a data block on tape (there can be several observations per block). The dates in the report, therefore, do not necessarily correspond to the beginning and end of the year.

For data on disk, no report is written but a warning message is written to the error/message file, which is repeated in the general report file, indicating that no data were retrieved.

MPRM RUN TIME AND FILE STATISTICS

The following tables present the amount of time it took to run various scenarios and the resulting file sizes. The VAX CPU time is the time that appears in a VAX log-file and the file sizes are expressed in blocks, where one block equals 512 bytes. Several factors affect the size of these files. For example, in extracting upper air soundings from magnetic tape, if the automatic data modification option is turned on and there are several modifications, then the error/message file may become quite large. This is evident in case A in Table 6-2a. Also, the more heights there are in the soundings, the larger the output file, as seen in cases A and B. The number of quality assessment violations affects the size of the error/message file. In case E there were a significant number of violations reported, whereas in case F, the surface observation quality

TABLE 6-2a. VAX RUN TIME AND FILE STATISTICS

Case	CPU Time (mm:ss)	Report Files Error/Message (blocks)	Report Files General (blocks)	Output File (blocks)
A. Extract Upper Air Soundings (1st year of 7 years on tape)	4:19	115	6	798
B. Extract Upper Air Soundings (7th year of 7 years on tape)	14:13	131	6	849
C. Extract Mixing Heights (1 year, on disk)	0:10	2	6	22
D. Extract Upper Air Soundings (as in case A) and Mixing Heights (as in case C) (1 year)	4:15	115	7	799
E. Quality Assess data from case D	1:38	346	8	800
F. Extract NWS Surface Obs. (1 year, on disk)	3:51	2	6	2644
G. Quality Assess data from case F	4:45	286	11	2644
H. Extract/Quality Assess On-site data (4 days, on disk)	0:24	30	9	27
I. Merge data from cases C and G (1 year)	4:28	2	39	1966
J. Merge data from cases E, G, and H (4 days)	0:19	2	9	59
K. RAMMET format from Stage 3 from case I	1:35	1	16	492
L. RAMMET format from Stage 3 from case J	0:15	27	3	6

TABLE 6-2b. PERSONAL COMPUTER RUN TIME AND FILE STATISTICS

Case	Real Time (mm:ss)	Report Files Error/Message (Kb)	Report Files General (Kb)	Output File (Kb)
A. Extract Upper Air Soundings (1st year of 7 years on tape)	-	-	-	-
B. Extract Upper Air Soundings (7th year of 7 years on tape)	-	-	-	-
C. Extract Mixing Heights (1 year, on disk)	0:44	0.7	2.9	10.8
D. Upper Air Soundings and Mixing Heights (1 year, file downloaded from VAX)	-	-	-	408.7
E. Quality Assess data from case D	15:07	174.5	3.8	409.3
F. Extract NWS Surface Obs. (1 year, on disk)	38:47	0.8	3.0	1344.5
G. Quality Assess data from case F	56:22	144.0	5.4	1344.9
H. Extract/Quality Assess On-site data (4 days, on disk)	2:20	14.8	4.4	13.3
I. Merge data from cases C and G (1 year)	34:48	0.7	19.4	1075.5
J. Merge data from cases E, G, and H (4 days)	2:06	0.8	4.5	29.8
K. RAMMET format from Stage 3 from case I	9:36	0.3	7.8	252.6
L. RAMMET format from Stage 3 from case J	1:23	0.6	8.4	2.8

assessment, there were very few violations. Both data sets are for one year of data.

When running the MPRM processor on a personal computer, the user should try to have sufficient disk space to store these files before starting a run. The times in Table 6-2b represent the difference in time between calls to the system clock when the processor is started and upon completion of a test case. The system used for these tests was an XT-compatible running at 8.0 MHz with an 8087 math co-processor present.

Note that the general report file is nearly constant for Stage 1 and 2 processing. The size of this file for Stage 3 processing can be affected by the options chosen. In these examples processing was requested for RAMMET output with no listing of the generated meteorological values. The Stage 3 general report for case K, where one year of data were processed, was 7.8 Kb. If the output meteorology are listed, using the JB LST option, the general report becomes 489.7 Kb, which translates to about 125 printed pages.

The upper air soundings were extracted from a magnetic tape that contained seven years (1964 - 1970) from Dayton, Ohio in the TD-5600 format. One year of mixing heights, also for Dayton, Ohio, resided on disk and were extracted on both the VAX and a personal computer. To compare run-time statistics between the VAX and personal computer, the extracted soundings and mixing heights file generated by test case D was downloaded from the VAX. One year of NWS surface observations also resided on disk and were downloaded from the VAX to the personal computer. The data were in an unblocked CD-144 format, i.e., there were 80 characters/record with each record containing one hourly observation. See Sections 1 and 3 for additional discussions of the data formats. The on-site data used here consisted of four days of data with four observations per hour. The size of the input file for test case H was 89 blocks on the VAX and 44.4 Kb on the personal computer. The output file consisted of one observation per hour. The data consisted of a date and time group and a single temperature difference in the first record followed by two records of vector data. The first vector record consisted of a height and a wind speed, and the second record consisted of a height, wind speed, wind direction, temperature and σ_a.

In test case I, the mixing height file was not quality assessed because these runs were to accumulate time and file statistics. For regulatory use, quality assessment of the mixing heights would be required prior to merging the data.

For Stage 3 processing, cases K and L, output was in RAMMET format and the processor was run in default mode, i.e., the LST and TRA options were not activated, to produce the smallest general report file possible.

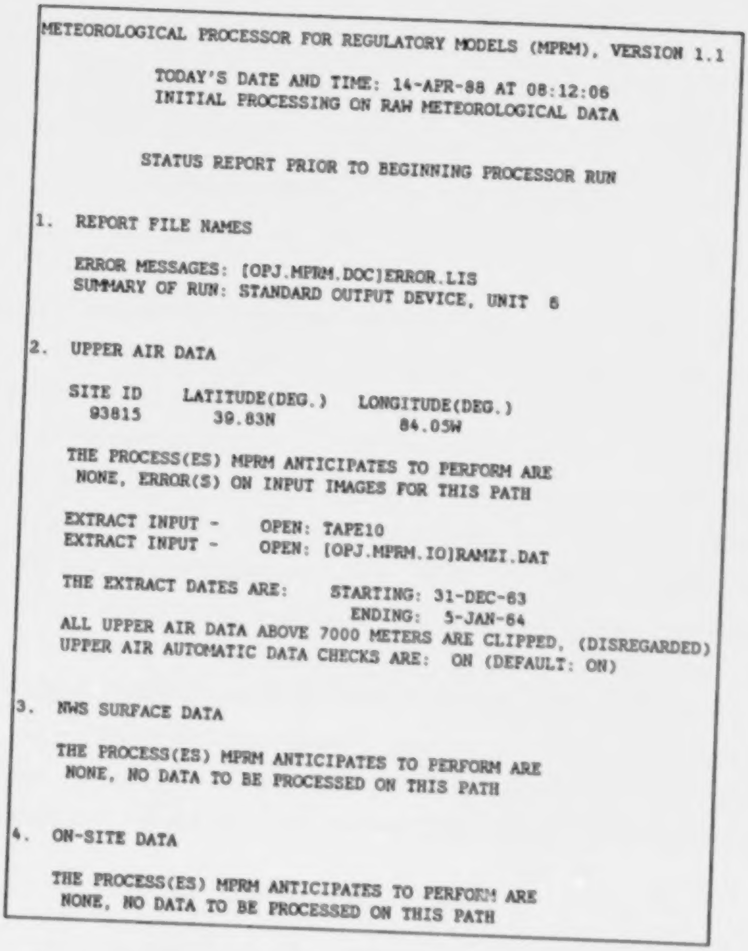
SECTION 7

INTERPRETING PROCESSING ERRORS

Suppose, as happens on occasion, an improper input run stream is fashioned. To investigate such an event, we will purposely leave out a necessary input image from the first run stream example shown in Section 4. Recall, that in this example the goal was to extract mixing height data and upper air observations and store these data in a file for subsequent quality assessment. The file for storage of the extracted data is defined in the UA IQA image. How will MPRM react to omission of the UA IQA image? The MPRM processor checks the input data for completeness before any data processing is attempted. It will detect that the UA IQA data input image is missing and will stop processing after all the input images have been processed. A message will be placed in the error/message file; this message is repeated within the general report file (beneath the message summary table) indicating that the output file for data extracted was not specified.

Note that MPRM will read and attempt to decipher all the input images. When an end-of-file (or JB END statement) is encountered on the input file, the processor reviews the images processed to see if errors were detected. If any errors were detected, further processing is inhibited except to generate a general report. If the JB RUN image is included in the run stream, MPRM will only read the run stream for syntax errors or omissions, but will stop before actual data processing occurs. The JB RUN image can be very useful in debugging run streams.

If the UA IQA input was omitted, the status report on first page of the general report would appear as shown in Figure 7-1. Since an error was detected in the UA-pathway run stream data, the message reports that no UA



```
METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

          TODAY'S DATE AND TIME: 14-APR-88 AT 08:12:06
          INITIAL PROCESSING ON RAW METEOROLOGICAL DATA


        STATUS REPORT PRIOR TO BEGINNING PROCESSOR RUN

1.  REPORT FILE NAMES

    ERROR MESSAGES: [OPJ.MPRM.DOC]ERROR.LIS
    SUMMARY OF RUN: STANDARD OUTPUT DEVICE, UNIT  6

2.  UPPER AIR DATA

    SITE ID    LATITUDE(DEG.)   LONGITUDE(DEG.)
     93815         39.83N            84.05W

    THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
     NONE, ERROR(S) ON INPUT IMAGES FOR THIS PATH

    EXTRACT INPUT -    OPEN: TAPE10
    EXTRACT INPUT -    OPEN: [OPJ.MPRM.IO]RAMZI.DAT

    THE EXTRACT DATES ARE:     STARTING: 31-DEC-63
                                 ENDING:  5-JAN-64
    ALL UPPER AIR DATA ABOVE 7000 METERS ARE CLIPPED, (DISREGARDED)
    UPPER AIR AUTOMATIC DATA CHECKS ARE:  ON (DEFAULT: ON)

3.  NWS SURFACE DATA

    THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
     NONE, NO DATA TO BE PROCESSED ON THIS PATH

4.  ON-SITE DATA

    THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
     NONE, NO DATA TO BE PROCESSED ON THIS PATH
```

Figure 7-1. First page of general report.

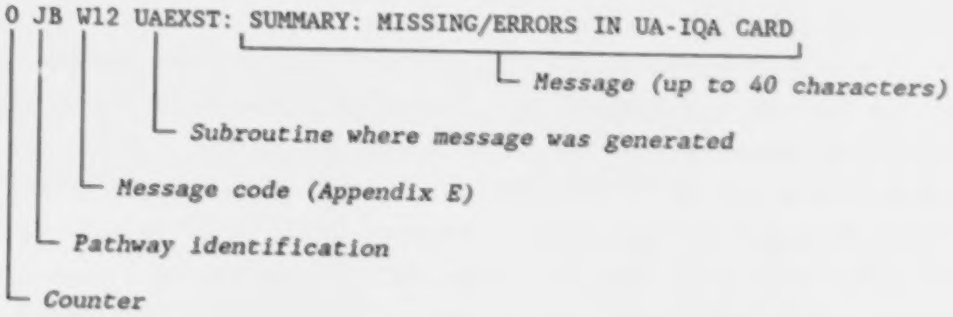
data will be processed. This message was generated because the IQA image, which defines the output file for storage of the extracted data, was omitted from the run stream for this example. Even though the processing of UA data was inhibited, the file names, the status of each file name, and the extraction dates are still reported for verification by the user. Because there were no surface observations or on-site data to process, a message to that effect is written for their respective pathways.

All messages generated during processing can be found in the error/message file, defined in the JB ERR input image. This file can be very long if there are a substantial number of messages; therefore, the file's contents should be reviewed before the file is printed. The messages generated by this example are shown in Figure 7-2.

```
11 JB I19  SETUP: ENCOUNTERED END OF "JOB/RUN CARD"
 0 JB W12 UAEXST: SUMMARY: MISSING/ERRORS IN UA-IQA CARD
 0 JB I10   TEST: SUMMARY: NO SF-EXT CARD, NULL EXTRACT
 0 JB I11   TEST: SUMMARY: NO SF-IQA CARD, NULL QA
 0 JB I12   TEST: SUMMARY: NO SF-OQA CARD, NULL MERGE
 0 JB I10   TEST: SUMMARY: NO OS-EXT CARD, NULL EXTRACT
 0 JB I11   TEST: SUMMARY: NO OS-IQA CARD, NULL QA
 0 JB I12   TEST: SUMMARY: NO OS-OQA CARD, NULL MERGE
```

Figure 7-2. Error/message file.

The second message in the file (generated by the omission of the UA IQA image) stopped data processing. This message is deciphered below.


0 JB W12 UAEXST: SUMMARY: MISSING/ERRORS IN UA-IQA CARD
Message (up to 40 characters)
Subroutine where message was generated
Message code (Appendix E)
Pathway identification
Counter

The structure of all messages is identical. In the first field of the message is a counter, which in this particular case has no significance. The second field indicates that the message was generated at the JB level of logic within the processor. The conditions for the generation of messages are:

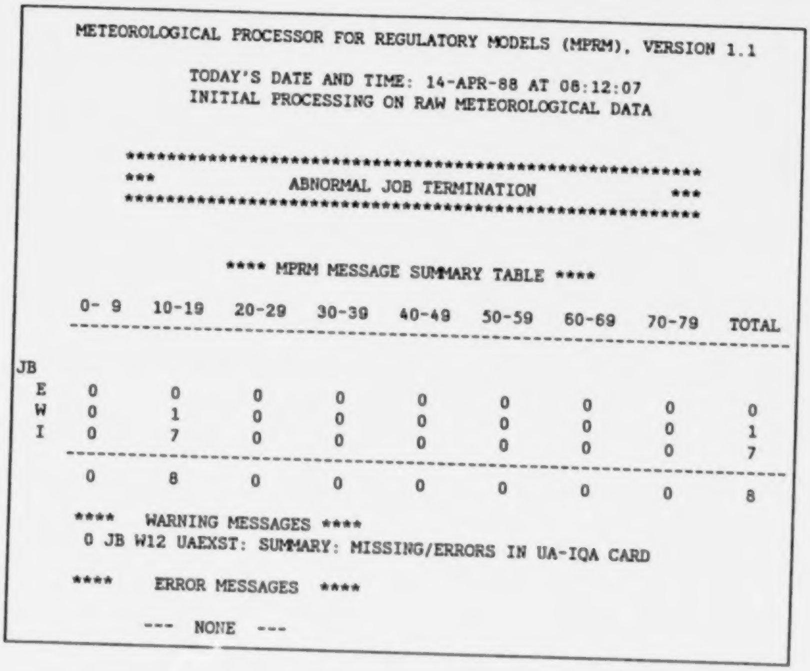
- o JB messages - most often when problems are encountered in deciphering the input run stream or when the processor detects incomplete run stream information.

- UA, SF, OS, and MR messages - when problems are encountered in deciphering a input run stream for the respective pathway, when data cannot be properly read, or when suspect data are encountered during a quality assessment check.

The third field is a three-character message code. The first character indicates the type of message: informational, warning, error, quality assessment, trace. In the example, the W indicates that this message is a warning. Warnings do not necessarily prohibit data processing; error messages do. The two numbers following the first character are used to provide additional information concerning this message. This additional information is provided in Appendix E. In general, messages concerning input run stream have message numbers from 0 to 20. Message numbers greater than 20 are generated while reading data files or during quality assessment checks.

The second page of the general report summarizes the processor activities (Figure 7-3). Beneath the heading is a message indicating the status when processing was completed. For this example, the message reports an ABNORMAL JOB TERMINATION. Following this message is the tabular summary of the messages codes generated during processing. The report concludes with a list of the warning and error messages, sorted by pathway ID. These messages are identical to the ones in the error file. Informational messages (codes that begin with I) and quality assessment violations (codes that begin with Q) are not listed within the summary report.

In this example with the missing UA IQA image, information on a single error can be traced through both the error/message file and the general report. The first sign of the error was the generation of the message indicating that no UA data would be processed because errors were detected in the input run stream. The next indication of the error was the display of the "ABNORMAL JOB TERMINATION" message just above the table summarizing the types of messages generated. One warning message was listed below the



```
        METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                     TODAY'S DATE AND TIME: 14-APR-88 AT 08:12:07
                     INITIAL PROCESSING ON RAW METEOROLOGICAL DATA

            *******************************************************
            ***                ABNORMAL JOB TERMINATION         ***
            *******************************************************

                         **** MPRM MESSAGE SUMMARY TABLE ****

         0- 9   10-19   20-29   30-39   40-49   50-59   60-69   70-79   TOTAL
        ---------------------------------------------------------------------
JB
   E     0        0       0       0       0       0       0       0       0
   W     0        1       0       0       0       0       0       0       1
   I     0        7       0       0       0       0       0       0       7
        ---------------------------------------------------------------------
         0        8       0       0       0       0       0       0       8

        ****   WARNING MESSAGES ****
         0 JB W12 UAEXST: SUMMARY: MISSING/ERRORS IN UA-IQA CARD

        ****    ERROR MESSAGES   ****

                --- NONE ---
```

Figure 7-3. Second page of general report.

summary table, which reported that the IQA input for the UA-pathway either was missing or had been entered in error. This warning, which is also listed within the error/message file, prompts a check of the IQA input for the UA-pathway. Once some familiarity is gained with the processor and with developing the input data, the user should begin to see the relationships between the abnormal job terminations and the messages generated by the processor.

APPENDIX A
SUMMARY OF INPUT KEYWORDS

INTRODUCTION

The following tables define the keywords used in the input to the MPRM processor. The logic within the processor, and hence the input to the processor, can be functionally divided into one of five major areas. These areas are called pathways and derive their names from the functions performed. Each pathway has one of the following two-letter acronym designations:

- o QA - input data that pertains to performing quality assessment
- o JB - processing that pertains to the entire processing job
- o UA - processing of NWS upper air data and NCDC mixing height data
- o SF - processing of NWS surface weather observations
- o OS - processing of user supplied (on-site) meteorological data
- o MR - processing that combines all available meteorological data for each day
- o MP - processing that pertains to dispersion model meteorology.

Separate tables are presented for each pathway. Input data to the processor is always directed to one of these five logical pathways. There are basically four processing tasks that might be involved. Each of these tasks has been assigned one of the following two-letter acronyms:

- EX - input data that pertains to reading raw data files and storing data in files for later processing checks of data

- MR - input data that pertains to combining (merging) data from various sources into one data file

- MP - input that pertains to developing a meteorological data file for use with a specific dispersion model.

In the tables, the keywords used for each pathway are listed along with a brief description of the input associated with each keyword. Beneath the columns, labeled by task, is shown whether the input defined by a particular keyword is mandatory (M) or optional (O). If neither an M or O is shown, that keyword is not relevant or used for that task.

The syntax of the input data is:

```
AA BBB C--------------------------------------------------C
|  |   |
|  |   |________ Dependent on pathway and keyword
|  |_________ 3-character Keyword
|___ 2-character Pathway ID (i.e., JB, UA, SF, OS, or MR)
```

HOW TO USE THESE TABLES

Appendices A and B are designed to be used together. Given that the user comes to this appendix with a specific task in mind, the user can determine which keywords will be needed to develop the input for each pathway.

The user can consult Appendix B to see the syntax associated with each keyword, and any variations particular to a given pathway.

JB keywords	EX	QA	MR	MP	Description and usage
FIN	M	M	M	M	Signals the completion of input data for this pathway.
ERR	M	M	M	M	Defines disk file name for processor generated warning and error messages.
STA	O	O	O	O	Defines the beginning of input data for pathway.
OUT	O	O	O	O	Defines disk file name for the general report.
RUN	O	O	O	O	If present, processing STOPS following completion of processing input images. Useful for checking input images.
END	O	O	O	O	Alternate method for signaling the end of the input data. Default is encountering an End-Of-File (EOF) in reading the input data.

UA keywords	EX	QA	MR	MP	Description and usage
FIN	M	M	M		Signals the completion of input data for this pathway.
STA	O	O	O		Defines the beginning of input data for pathway.
LOC	M	M	M		Defines station ID, station longitude and latitude, and number of hours to convert times given in data to LST.
IQA	M	M			Defines disk file name for storage of extracted data and input data for QA processing.
OQA		M	M		Defines disk file name for storage of QA processed data and input data for MERGE.
EXT	M				Defines EXTRACT start and stop dates.
IN1	(M)				Defines tape name, format, and characteristics for upper air data.
IN2	(M)				Defines tape name and characteristics, or disk file name and format for morning and afternoon mixing height data.
TOP	O				Upper air data for altitudes above ground greater than UATOP are ignored. Default value of UATOP is 5000 m.
OFF	O				Turns off automatic data modifications during EXTRACT of upper air soundings. By default adjustments are made to correct suspect temperatures, redefine directions associated with calm winds, delete (when possible) data given for mandatory pressure levels, fill in missing dew-point temperatures, and adjust heights to AGL.
CHK		O			Redefines QA range checks and missing value flag for a variable.
AUD		O			Adds variable to general AUDIT report. Default variables are UAM1 and UAM2, morning and evening mixing heights.

(M) One or both of IN1 and IN2 must be present, if EXT is present.

SF keywords	EX	QA	MR	MP	Description and usage
FIN	M	M	M		Signals the completion of input data for this pathway.
STA	O	O	O		Defines the beginning of input data for pathway.
LOC	M	M	M		Defines station ID, station longitude and latitude, and number of hours to convert times given in data to LST.
IQA	M	M			Defines disk file name for storage of extracted data and input data for QA processing.
OQA		M	M		Defines disk file name for storage of QA processed data and input data for MERGE.
EXT	M				Defines EXTRACT start and stop dates.
IN2	M				Defines tape name and characteristics, or disk file name and format of hourly weather observation data.
CHK		O			Redefines QA range checks and missing value flag for a variable.
AUD		O			Adds variable to general AUDIT report. Default variables are: SLVP Sea-level station pressure PRES Uncorrected station pressure CLHT Ceiling height TSKC Total and Opaque sky cover HZVS Horizontal visibility TMPD Dry-bulb temperature WD16 Wind direction WIND Wind speed.

OS keywords	EX	QA	MR	MP	Description and usage
FIN	M	M	M		Signals the completion of input data for this pathway.
STA	O	O	O		Defines the beginning of input data for pathway.
LOC	M	M	M		Defines site ID, site longitude and latitude, and number of hours to convert times given in data to LST.
IQA	M	M			Defines disk file name for storage of input data for QA processing. May have more than one observation per hour.
OQA		M	M		Defines disk file name for storage of QA processed data and input data for MERGE. Always hourly averages.
EXT	O				Defines EXTRACT start and stop dates.
MAP	M	M	M		Defines order of OS input variables as they appear within IQA file.
FMT	M	M	M		Defines FORTRAN format statements for reading IQA file.
AVG	O	O			Defines maximum number of observations to be expected per hour for input data provided within IQA file.
DT1	O	O			Defines lower and upper measurement heights associated with first temperature difference.
DT2	O	O			Defines lower and upper measurement heights associated with second temperature difference.
DT3	O	O			Defines lower and upper measurement heights associated with third temperature difference.

OS keywords	EX	QA	MR	MP	Description and usage
HGT	O	O			Defines meteorological mast configuration, number of levels, and height associated with each.
CLM	O	O			Defines valid minimum wind speed for use in definition of calm wind.
CHK		O			Redefines QA range checks and missing value flag for a variable.
AUD		O			Adds variable to general AUDIT report. Default variables are: MHGT Mixing height SA SD of horizontal wind direction SE SD of vertical wind direction TT Dry-bulb temperature WD Horizontal mean wind direction WS Horizontal mean wind speed.
SFC		O			Defines surface characteristics. Default values are albedo, 0.25; Bowen ratio, 0.75; and surface roughness length, 0.15 m.

MR keywords	EX	QA	MR	MP	Description and usage
OUT			M		Defines disk file name for storage of combined (merged) data.
FIN			M		Signals the completion of input data for this pathway.
EXT			O		Defines start and stop dates for MERGED data.
STA			O		Defines the beginning of input data for pathway.

MP keywords	EX	QA	MR	MP	Description and usage
FIN				M	Signals the completion of input data for this pathway.
STA				O	Defines the beginning of input data for pathway.
MET				M	Defines disk file name associated with combined (merged) meteorological data file.
MMP				M	Defines disk file name associated with output meteorological file created by this run. Included as an option is the ability to define the dispersion model that will be accessing this file.
EXT				O	Defines start and stop dates for meteorological data file to be created by this run.
VBL				O	Redefines (override default) processing methodology to be employed in generating output meteorological data file. Currently there are selection options available for processing wind, temperature, stability category, and mixing height. Choice is largely whether to use NWS or on-site meteorological data.
TRA				O	Turns on more detailed trace of errors encountered during processing. Default is to provide daily summaries.
LST				O	Turns on listing of generated meteorology to general report file.

APPENDIX B

SUMMARY OF INPUT SYNTAX

INTRODUCTION

In the following tables, the keywords used in the input to the MPRM processor are presented in more detail. The first two tables explain the keywords used in defining the input files and tapes and the output files. These are presented first, as they are likely to be consulted most often.

Presented next are tables for the rest of the keywords, arranged in alphabetical order by keyword.

The specific information provided for each keyword is the pathway(s) employing the keyword and the syntax of the input image employing the keyword. The description for each keyword concludes with one or more examples to illustrate typical usage.

HOW TO USE THESE TABLES

Appendices A and B are designed to be used together. Since the user comes to this appendix with a specific task in mind, the user can determine what information is defined by each keyword (Appendix A) and the syntax of the input image employing the keyword (Appendix B).

The user can consult Appendix A to see which keywords are mandatory and which are optional, dependent on tasks to be performed and pathway involved.

Defining Diskfile Names

Keywords: ERR, IQA, OUT, OQA on PathwayIDs JB, UA, SF and OS
Purpose: Define diskfile name.

```
PathwayID  Keyword  Keyword1  Filename
                    └──────────────────── Keyword1 always equals DISK.

IBM PC example:  JB OUT DISK REPORT.LIS
VAX    example:  JB OUT DISK [JSI.MPRM.FORT]REPORT.LIS
```

Keyword: IN2 on PathwayID UA
Purpose: Define diskfile name containing mixing height data.

```
PathwayID  Keyword  Keyword1  Filename  Form-or-Format  SiteID
                    │                                   │
                    │                         Station identification
                    │
                    └──────────────────────── Keyword1 is either
                                              DISK or USER.
```

If DISK, then Form-or-Format must be 9689FB.

If USER, then Form-or-Format must be a valid FORTRAN format. The input list to be read is of the form: AAAA,YEAR,MONTH,DAY,UAM1,UAM2. Where AAAA is station ID (note even though this is typically a 5-digit number, it is input as a CHARACTER variable).

YEAR	is last 2-digits of year.
MONTH	is month (1 = January, 2 = February, etc).
DAY	is day of month.
UAM1	is the morning urban mixing height to nearest meter.
UAM2	is the afternoon mixing height to nearest meter.

Note, YEAR, MONTH, DAY, UAM1 and UAM2 are input as INTEGER variables.

```
Examples: UA IN2 DISK CSCZIDAT.DAT 9689FB  13840
          UA IN2 USER CSCZIDAT.DAT (A5,3I2,2X,I4,14X,I4) 13840
```

Defining Diskfile Names (Continued)

Keyword: IN2 on PathwayID SF
Purpose: Define diskfile name containing hourly surface data.

PathwayID Keyword Keyword1 Filename Form SiteID

SiteID: Station identification

Form: Form always equals CD144FB.

Keyword1: Keyword1 always equals DISK.

```
Example: SF IN2 DISK CSCSFDAT.DAT  CD144FB    13840
```

Defining Tapefile Names

Keyword: IN1 on PathwayID UA
Purpose: Define tapefile containing upper air data.

PathwayID Keyword Keyword1 Tapename Form Format SiteID

SiteID: Station identification

Format: Either ASCII or EBCDIC, (always ASCII on IBM).

Form: Form is 5600FB or 5600VB. FB stands for Fixed-block and VB stands for Variable-block formatting on tape.

Keyword1: Keyword1 always equals TAPE

```
Example: UA IN1 TAPE TAPE1 5600VB EBCDIC  13840
```

Defining Tapefile Names (Continued)

Keyword: IN2 on PathwayID UA
Purpose: Define Tapefile containing mixing height data

```
PathwayID  Keyword  Keyword1  Tapename  Form  Format  SiteID
                       |                  |      |       |
                       |                  |      |     Station
                       |                  |      |     identification
                       |                  |      |
                       |                  |    Either ASCII or EBCDIC,
                       |                  |    (always ASCII on IBM).
                       |                  |
                       |                  |__ Form is always 9689FB.
                       |                      FB stands for Fixed-block
                       |                      formatting on tape.
                       |
                       |__ Keyword1 always equals TAPE

   Example: UA IN2 TAPE TAPE2 9689FB ASCII  13840
```

Keyword: IN2 PathwayID SF
Purpose: Define tapefile containing hourly surface data.

```
PathwayID  Keyword  Keyword1  Tapename  Form  Format  SiteID
                       |                  |      |       |
                       |                  |      |     Station
                       |                  |      |     identification
                       |                  |      |
                       |                  |    Either ASCII or EBCDIC,
                       |                  |    (always ASCII on IBM).
                       |                  |
                       |                  |__ Form is always CD144FB.
                       |                      FB stands for Fixed-block
                       |                      formatting on tape.
                       |
                       |__ Keyword1 always equals TAPE

   Example: SF IN2 TAPE TAPE3 CD144FB EBCDIC  13840
```

Keyword: AUD used on PathwayIDs UA, SF, and OS
Purpose: Add variables to audit summary report.

```
PathwayID  Keyword   PRM1, PRM2, ...
                      |    |
                      |    └─ 4-character variable name
                      |
                      └──── 4-character variable name
```

PRM1, PRM2 - the available 4-character names of the variables are provided in Appendix C.

The AUD input can be repeated as often as needed in order to list all the variables to be added to the audit summary.

The default list of audit variables on the UA-pathway are the twice-daily mixing height values.

The default list of audit variables on the SF-pathway are: sea-level pressure, station pressure, ceiling height, total sky cover, horizontal visibility, dry-bulb temperature, wind direction and wind speed.

The default list of audit variables on the OS-pathway are: mixing height, wind speed, wind direction, temperature, σ_a, and σ_e.

```
Example: OS AUD DT01,DT02
         OS AUD PRES,TSKC
```

Keyword: AVG used only on PathwayID OS
Purpose: Define maximum number of observations per hour.

PathwayID Keyword VALUE

VALUE is the maximum number of on-site observations expected during an hour. The default value is 1. The maximum value allowed is 12.

Example: OS AVG 12

Keyword: CHK used on PathwayIDs UA, SF, and OS
Purpose: Alter quality assessment range check parameters.

PathwayID Keyword PRM1 PRM2 PRM3 PRM4 PRM5

PRM5 — Upper bound of range
PRM4 — Lower bound of range
PRM3 — Missing value indicator
PRM2 — Range check switch
PRM1 — Name of variable

PRM1 - 4-character name for scalars variables and 2-character names for multi-level on-site variables (names listed in Appendix C)

PRM2 - Integer input, either 1 or 2

PRM3 - Integer input, be sure missing value indicator is not also an acceptable value for the variable

PRM4 - Integer input, be realistic to insure useful quality assessment checks

PRM5 - Integer input, be realistic to insure useful quality assessment checks

```
Examples: OS CHK DT01 1 -999 -2 10
          OS CHK WS   1 -99   0 50
```

Keyword: CLM used only on PathwayID OS
Purpose: Define wind threshold speed.

PathwayID Keyword VALUE

VALUE is the threshold wind speed for valid wind measurements, in meters per seconds, used in defining calms.

```
Example: OS CLM  0.45
```

Keywords: DT1, DT2 and DT3 used only on PathwayID OS
Purpose: Define heights associated with Delt-T measurements.

PathwayID Keyword LHEIGHT UHEIGHT

LHEIGHT	Lower height of temperature difference measurement in meters.
UHEIGHT	Upper height of temperature difference measurement in meters.

(Values may be entered as real or integer as shown in example below.)

Example: OS DT2 2.0 10

Keyword: END used only PathwayID JB
Purpose: Signals end of input run stream for entire job.

PathwayID Keyword

This keyword has no parameters.

Example: JB END

Keyword: EXT used on PathwayIDs MP, UA, SF, OS and MR
Purpose: Define start and stop dates for processing.

PathwayID Keyword YY1 MM1 DD1 YY2 MM2 DD2

YY1, MM1 and DD1 define the starting year, month and day of the data to be retrieved (merged on PathwayID MR). YY2, MM2 and DD2 define the ending year, month and day of the data to be retrieved (merged on PathwayID MR). Note, these dates are inclusive, so data for day DD2 will be included. All values are input as INTEGERS. YY1 and YY2 can be expressed fully or by last two digits, for example 1987 or 87.

Example: UA EXT 84 1 1 84 12 31

Keyword: FIN used on PathwayIDs JB, MP, UA, SF, OS AND MR
Purpose: Signals end of input run stream for pathway.

PathwayID Keyword

This keyword has no parameters.

Example: JB FIN

Keyword: FMT used only on PathwayID OS
Purpose: Define FORTRAN formats for reading input data.

```
PathwayID  Keyword  Keyword1  PRM
                     |         |
                     |         └ A valid FORTRAN format
                     |
                     |
                     └ Keyword1 equals DATxx , where xx
                       are INTEGERS such as 01, 02, 03 etc.
```

DATxx - the xx refers to sequence number. For instance, if there are three READs (in the FORTRAN sense) needed for reading the data, then there would be DAT01, DAT02 and DAT03 definitions within the OS MAP input <u>and</u> there would likewise be DAT01, DAT02 and DAT03 definitions within the OS MT input.

PRM - this includes the right and left parentheses.

Example:

```
OS MAP DAT02 INSO TSKC CLHT
OS FMT DAT02 (5X,F4.2,2X,2F5.2)
                 |
                 └ Note the specification of the
                   number of decimal places.  This
                   is not necessary for proper input
                   of the value, but since we use
                   this format in writing to the
                   OQA-file, we NEED the decimal
                   specification.
```

Keyword: HGT used only on PathwayID OS
Purpose: Define heights associated with multilevel input data.

PathwayID Keyword NN HGT1 HGT2 ... HGTNN

NN	Number of heights to be read in as input. (Maximum: 10)
HGT1 ... HGTNN	N values of heights, in meters.

(You can not repeat this card, so all values must be listed.)

Example: OS HGT 5 2.0 4.0 10 30.0 50

Keyword: LOC used on PathwayIDs UA, SF and OS
Purpose: Define location parameters for site.

PathwayID Keyword SiteID AAAAAA BBBBBB GMTLST

SiteID	Site identification number. Typically, this is a 5-digit number. To avoid conflicts with current dispersion models expecting RAMMET type meteorological input, we suggest the OS pathway SiteID contain only numbers, no letters. **Note, SiteID MUST agree with that given in the INPUT data.**
AAAAAA and BBBBBB	These two data entries are the longitude and latitude in decimal degrees. Longitude and latitude can appear in either position AAAAAA or BBBBBB. The important point is to define both. North and south latitude are entered as 30.00N and 30.00S. Likewise, the longitude is entered as 170.13E.
GMTLST	The number of hours to be subtracted to convert times given on this pathway to Local Standard Time (LST). If times are given as Greenwich Mean Time (likely on UA pathway), for the east coast of the United States, GMTLST would be 5. Note, if times are given in LST, a zero must still be given as input for GMTLST.

Example: UA LOC 03820 34.37N 81.97E 5

Keyword: LST used only on PathwayID JB
Purpose: Turn on printed listing of generated meteorological data.

PathwayID Keyword

This Keyword has no parameters.

Example: MP LST

Keyword: MAP used only on PathwayID OS
Purpose: Define sequence of variables for data records.

```
PathwayID  Keyword  Keyword1  PRM1, PRM2, PRM3, ....
                       |          |
                       |          └ PRM1, PRM2, etc. are the 4-character
                       |            variable names for the OS variables to
                       |            be processed.
                       |
                       └ Keyword1 equals DATxx, where xx
                         are INTEGERS such as 01, 02, 03 etc.
```

The MAP data describe the order and structure of the OS data to be processed. There are several assumptions made, but given these rules are followed, a variety of data sets can be processed with little to no restructuring.

Rule 1. Each OS observation is completely labeled with a date and time, which will at least define the year, month, day and hour of the OS observation.

Rule 2. The date and time data are given as INTEGERS and are the first data presented in the OS observation. Note, the order is unimportant, presenting year, month and day is just as acceptable as presenting day, month and year.

Rule 3. The rest of the OS data, such as mixing heights, insolation, wind speed etc.), are presented FOLLOWING the DATE and TIME data.

Limits: There can be up to 20 records of input in one observation. Each record is limited to have no more than 40 variables. The multi-level variables are limited to no more than 10 levels.

Keyword: MAP used only on PathwayID OS (continuation of discussion):

PathwayID Keyword Keyword1 PRM1, PRM2, PRM3, ...

PRM1, PRM2, etc. are the 4-character variable names for the OS variables to be processed.

Keyword1 equals DATxx, where xx are INTEGERS such as 01, 02, 03 etc.

Appendix C lists the 4-character names to be used in defining PRM1, PRM2, ... etc.

DATxx defines the sequence for the input. The xx indicates the record number, as DAT01 is the first record of data and DAT02 is the second record of data.

Example:

```
OS MAP DAT01 OSYR OSMO OSDY OSHR OSMN
OS MAP DAT02 TT01 WS01
OS MAP DAT03 TT02 WS02 WD02 SA02
```

The above three input images employ the MAP keyword. They describe to the processor the input data records for one time period.

Keyword: MAP used only on PathwayID OS (continuation of discussion):

```
PathwayID  Keyword  Keyword1  PRM1, PRM2, PRM3, ....
                       |        |
                       |        └ PRM1, PRM2, etc. are the 4-character
                       |          variable names for the OS variables to
                       |          be processed.
                       |
                       └ Keyword1 equals DATxx, where xx
                         are INTEGERS such as 01, 02, 03 etc.
```

DATxx rules:

DAT01 must begin with a date and time definition. The date must provide year, month and day. The time must provide hour of day, minutes is optional. The order of the date and time variables is not important.

PRM rules:

The scalar variable names are: ALTP, SLVP, PRES, CLHT, TSKC, HFLX, USTR, MHGT, ZOHT, SAMT, PAMT, INSO, NRAD, DT01, DT02, DT03, US01, US02, US03, OSDY, OSMO, OSYR, OSHR, OSMN

The multi-level variable names are: HT, SA, SE, SV, SW, SU, TT, WD, WS, VV, DP, RH, V1, V2, V3. These are the FIRST two letters of the 4-character names. The LAST 2 characters are the level on the tower to be associated with the variable (maximum: 10).

Keyword: MAP used only on PathwayID OS
(continuation of discussion):

PathwayID Keyword Keyword1 PRM1, PRM2, PRM3, ...

PRM1, PRM2, etc. are the 4-character variable names for the OS variables to be processed.

Keyword1 equals DATxx, where xx are INTEGERS such as 01, 02, 03 etc.

Below is an example of what the first data record of on-site data might look like (see example page B-11). As the data have a specific format, scales are given at the top and bottom to ease interpretation.

In the example, records 1 through 3 are for one time period The first record for each time period begins with a date and time group. For instance, deciphering record 1 we have, January 1, 1984 at 11:05 AM. Deciphering record 2 we have temperature 2° C and wind speed of 2.1 m/s. The third record is, temperature 1.99° C, wind speed 3.2 m/s, wind direction 112° and σ_a 32 degrees.

	12345678901234567890123456789012345678901234567890
Record number	Sample On-Site (OS) Input Data
1	84 01 01 1105
2	2.0 2.1
3	1.99 3.2 112. 32.
	12345678901234567890123456789012345678901234567890

There is no relationship assumed between the sequence number,xx, given in DATxx with the measurement level, yy, given in the multi-level variable name, as HT02.

Keyword: MET used only on PathwayID MP
Purpose: Define diskfile of merged data.

PathwayID Keyword Keyword1 Filename PRM

Keyword1 - always equal to DISK.

Filename - be sure to fully specify the filename.

PRM - Integer number of hours needed to be subtracted from Greenwich Mean Time to convert to Local Standard Time.

Examples:
```
MP MET DISK [JSI.MPRM.DAT]RAMSTL.DAT 5
MP MET DISK RAMSTL.DAT 5
```

Keyword: MMP used only on PathwayID MP
Purpose: Define dispersion model and diskfile name for output.

PathwayID Keyword Keyword1 Filename PRM

Keyword1 - always equal to DISK.

Filename - be sure to fully specify the filename.

PRM - (optional) Name of dispersion model. Current list of dispersion model names are BLP, RAM, ISCST, MPTER, CRSTER, COMPLEX1, CALINE-3, RTDM, VALLEY, ISCLT, CDM16 and CDM36. The default dispersion model is CRSTER. This output is equivalent to that produced by RAMMET.

Examples:
```
MP MMP DISK [JSI.MPRM.DAT]RAMMET.DAT
MP MMP DISK RAMMET.DAT CDM36
```

Keyword: OFF used only on PathwayID UA
Purpose: Turn off automatic modification checks to upper air data.

PathwayID Keyword

This keyword has no parameters.

Example:
```
UA OFF
```

Keyword: RUN used only on PathwayID JB
Purpose: Inhibit data processing; check run stream snytax and stop.

PathwayID Keyword

This keyword has no parameters.

Example: JB RUN

Keyword: SFC used only on PathwayID OS
Purpose: Define site characteristics.

PathwayID Keyword Keyword1 PRM1... PRM5

Meaning and number of parameters is dependent of definition of Keyword1.

Keyword1 is either SETUP, VALUES or SECTOR. The first time Keyword SFC data are given, the value of Keyword1 MUST be SETUP.

When Keyword1 is SETUP:

PRM1	is either ANNUAL, SEASONAL or MONTHLY. This defines the frequency (number of times) throughout the year that the Albedo, Bowen Ratio and Surface Roughness length will be defined.
PRM2	is the number of wind direction sectors to be used in defining values for the Albedo, Bowen Ratio and Roughness length. PRM2 can be any value 1 through 12.

When Keyword1 is VALUES:

PRM1	is the time period being defined. If PRM1 is ANNUAL on the SETUP image, then PRM1 is always 1 on the VALUES image. If PRM1 is SEASONAL on the SETUP image, then PRM1 is 1 through 4 on the VALUES image (1 = winter months: 12, 1 and 2; 2 = spring months: 3, 4 and 5 etc.). If PRM1 is MONTHLY on the SETUP image, then PRM1 is 1 through 12 on the VALUES image (1 = January, 2 = February etc.).
PRM2	is the wind direction sector being defined.
PRM3	is the Albedo for this time (PRM1) and wind sector (PRM2).
PRM4	is the Bowen ratio for this time (PRM1) and wind sector (PRM2).
PRM5	is the Roughness length for this time (PRM1) and wind sector (PRM2).

(continued)

Keyword: SFC used only on PathwayID OS
(continuation of discussion):

```
PathwayID  Keyword  Keyword1  PRM1... PRM5
                       |        |
                       |        └─ Meaning and number of parameters is
                       |           dependent of definition of Keyword1.
                       |
                       └─ Keyword1 is either SETUP, VALUES or SECTOR.
                          The first time keyword SFC data are given,
                          the value of Keyword1 MUST be SETUP.
```

When Keyword1 is SECTOR:

PRM1	is the wind sector number, it must be less than or equal to the value given for PRM2 on the SETUP image.
PRM2	is the beginning azimuth in degrees for this wind sector, reading in a clockwise sense. PRM2 must be a value between 0 through 360.
PRM3	is the ending azimuth in degrees for this wind sector, reading in a clockwise sense. PRM2 must be a value between 0 through 360.

Note, presently no checks are made to insure that the wind sectors are defined with no overlapping boundaries, and that a sufficient number of sectors are defined to cover all possible directions.

No checks are made to insure that the Albedo, Bowen ratio and Roughness length have been defined for all months and all wind sectors. Special cases can arise when such is not necessary. To define values for all months and sectors requires: (frequency)x(number of sectors) VALUES data cards, where frequency is 1, 4 or 12 for ANNUAL, SEASONAL and MONTHLY, respectively.

Example:

```
OS  SFC  SETUP  ANNUAL  2
OS  SFC  VALUES  1  1  0.6  0.5  0.3
OS  SFC  VALUES  1  2  0.8  0.6  0.1
OS  SFC  SECTORS  1  30  150
OS  SFC  SECTORS  2  150  30
```

Keyword: STA used PathwayIDs JB, MP, UA, SF, OS AND MR
Purpose: Signals beginning of input run stream data for pathway.

PathwayID Keyword

This keyword has no parameters.

Example: JB STA

Keyword: TOP used only on PathwayID UA
Purpose: Define 'clipping height' for upper air data.

PathwayID Keyword UATOP

UATOP is height in meters. Upper air data given for heights above ground greater than UATOP are ignored. Note, value must be entered as an INTEGER.

Example: UA TOP 7500

Keyword: TRA used only on PathwayID MP
Purpose: Turn on trace notes to provide details of processing.

PathwayID Keyword

This Keyword has no parameters.

Example: MP TRA

Keyword: VBL used only on PathwayID MP
Purpose: Define methodology for generating output variable.

```
PathwayID  Keyword  ITEM  ACTION  XXXX
                     |      |     └─── additional input,
                     |      |          as required.
                     |      |
                     |      └───────── 6-character keyword
                     |                 instructing processor
                     |                 how 'ITEM' is to be
                     |                 accomplished.
                     |
                     └──────────────── 4-character keyword
                                       defining process
                                       (methodology).
```

See Table 4-1 in Section 4 for input values acceptable for ITEM, Action and XXXX.

Examples: MP VBL WIND ONSITE 35.0
MP VBL STAB SASITE 10.0

APPENDIX C

VARIABLE NAMES AND DEFAULT RANGE CHECKS

MPRM gives the user the ability to override the internal definitions for upper and lower bounds, missing value indicator, and treatment of endpoints during quality assessment checks during Stage 1 processing. This appendix presents the following:

- Variable names used to override the parameters
- A description of each variable and the units used
- Quality assessment default parameters for each variable
- Variables automatically audited during quality assessment.

There are seven fields in each table: variable name, description, units, range check switch, missing flag, lower bound, and upper bound. Each of these fields is described below.

Variable name

This is the four-character variable name used in the input images for redefining quality assessment parameters (the CHK image on each pathway), activating auditing of variables not automatically audited (the AUD image on each pathway) and defining the on-site data map (the DAT and LVL images only on the OS-pathway).

If an asterisk (*) appears before the variable name, then the variable is automatically audited during quality assessment. These variables are always audited on the upper air and surface pathways. However, for the on-site pathway if the variable is not in the data map, then the variable is omitted from the audit. If a person wants to audit additional variables on any pathway, the AUD input image is used.

Description and units

A brief description and the units of each variable follows the name. For several variables, a multiplier also appears in the units field. This can be identified by the *10 or *100 (the only two multipliers used) that appears after the units. Because the upper air and surface observations are treated as integers within MPRM, multipliers are used to retain significant digits prior to rounding the value to the nearest integer.

Range Check Switch

The Range Check Switch field indicates whether to exclude the lower and upper bound (= 1) or include the bounds (= 2) in determining if the variable violates the prescribed limits. This value can be changed by using the CHK input image.

Missing Value Indicator

The missing value indicator is the value used in the processor to represent missing data for the variable. This value can be changed by the user on the CHK input image. This option is particularly useful if data are already extracted and a different missing value flag was used.

Bounds

The last two fields, the Lower and Upper bounds, are the limits against which the value of a variable is checked. If the value lies outside this interval, the endpoints either included or excluded according to the Range Check Switch, then a quality assessment violation is recorded. As in the Range Check Switch and Missing Flag, these values can be modified using the CHK card.

TABLE C-1. VARIABLE NAMES, UNITS, AND QUALITY ASSESSMENT DEFAULT SETTINGS FOR THE UA-PATHWAY

Variable name	Description	Units	Range check switch	Missing value indicator	Bounds	
					Lower	Upper
UAPR	Atmospheric pressure	millibars *10	1	-9999	5000	10999
UAHT	Height above ground level	meters	2	-9999	0	5000
UATT	Dry bulb temperature	^{0}C *10	1	-9999	-350	+350
UATD	Dew-point temperature	^{0}C *10	1	-9999	-350	+350
UAWD	Wind direction	degrees from north	2	-9999	0	360
UAWS	Wind speed	meters/second *10	1	-9999	0	500
UASS	Wind speed shear	(m/s)/(100 meters)	2	-9999	0	5
UADS	Wind direction shear	degrees/(100 meters)	2	-9999	0	90
UALR	Temperature lapse rate	^{0}C/(100 meters)	2	-9999	-2	5
UADD	Dew point deviation	^{0}C/(100 meters)	2	-9999	0	2
UAM1*	A.M. Mixing height	meters	2	-9999	50	500
UAM2*	P.M. Mixing height	meters	2	-9999	500	3500

*Automatically included in audit report.

TABLE C-2. VARIABLE NAMES, UNITS, AND QUALITY ASSESSMENT DEFAULT SETTINGS FOR THE SF-PATHWAY

Variable name	Description	Units	Range check switch	Missing value indicator	Bounds	
					Lower	Upper
ALTP	Altimeter pressure	inches of mercury	2	-9999	2700	3200
SLVP*	Sea level pressure	millibars *10	1	-9999	9000	10999
PRES*	Station pressure	millibars *10	1	-9999	9000	10999
CLHT*	Ceiling height	kilometers *10	2	-9999	0	300
TSKC*	Total//opaque sky cover	tenths//tenths	2	9999	0	1010
C2C3	2 level//3 level cloud cover	tenths//tenths	2	9999	0	1010
CLC1	Sky condition//cover, level 1	------//tenths	2	9999	0	910
CLC2	Sky condition//cover, level 2	------//tenths	2	9999	0	910
CLC3	Sky condition//cover, level 3	------//tenths	2	9999	0	910
CLC4	Sky condition//cover, level 4	------//tenths	2	9999	0	910
CLT1	Cloud type//height, level 1	------//(km *10)	2	99999	0	98300
CLT2	Cloud type//height, level 2	------//(km *10)	2	99999	0	98300
CLT3	Cloud type//height, level 3	------//(km *10)	2	99999	0	98300
CLT4	Cloud type//height, level 4	------//(km *10)	2	99999	0	98300
PWTH	Present weather (2 types)	------//-----	2	9999	0	9292
HZVS*	Horizontal visibility	kilometers *10	2	-9999	0	1640
TMPD*	Dry bulb temperature	^{0}C *10	1	-9999	-300	350
TMPW	Wet bulb temperature	^{0}C *10	1	-9999	-650	350
DPTP	Dew-point temperature	^{0}C *10	1	-9999	-650	350
RHUM	Relative humidity	whole percent	2	-9999	0	100
WD16*	Wind direction	tens of degrees	2	-9999	0	36
WIND*	Wind speed	meters/second *10	1	-9999	0	500

NOTE: The three pressure variables (ALTP, SLVP, and PRES), the ceiling height (CLHT), and the sky cover (TSKC) are also available on the OS-pathway.

*Automatically included in audit report.

//The two variables described have been combined to form one variable.

TABLE C-3. VARIABLE NAMES, UNITS, AND QUALITY ASSESSMENT DEFAULT SETTINGS FOR THE OS-PATHWAY

Variable name	Description	Units	Range check switch	Missing value indicator	Bounds	
					Lower	Upper
HFLX	Surface heat flux	watts/square meter	1	999	-50	800
USTR	Surface friction velocity	meters/second	1	999	0	2
MHGT*	Mixing height	meters	1	9999	0	4000
ZOHT	Surface roughness length	meters	1	999	0	2
SAMT	Snow amount	centimeters	2	999	0	250
PAMT	Precipitation amount	centimeters	2	999	0	100
INSO	Insolation	watts/square meter	1	9999	0	1250
NRAD	Net radiation	watts/square meter	1	999	-50	800
DT01	Temperature diff.(U - L)[1]	^{o}C/(100 meters)	1	9	-2	5
DT02	Temperature diff.(U - L)[1]	^{o}C/(100 meters)	1	9	-2	5
DT03	Temperature diff.(U - L)[1]	^{o}C/(100 meters)	1	9	-2	5
US01	User's scalar #1	user's units	1	999	0	100
US02	User's scalar #2	user's units	1	999	0	100
US03	User's scalar #3	user's units	1	999	0	100
HTnn	Height	meters	1	9999	0	4000
SAnn*	Std. dev. horizontal wind	degrees	1	99	0	35
SEnn*	Std. dev. vertical wind	degrees	1	99	0	25
SVnn	Std. dev. v-comp. of wind	meters/second	1	99	0	3
SWnn	Std. dev. w-comp. of wind	meters/second	1	99	0	3
SUnn	Std. dev. u-comp. of wind	meters/second	1	99	0	3
TTnn*	Temperature	^{o}C	1	99	-30	35
WDnn*	Wind direction	degrees from north	2	999	0	360
WSnn*	Wind speed	meters/second	1	999	0	50
VVnn	Vertical component of wind	meters/second	1	999	0	5

[1] (U - L) indicates (upper level) - (lower level).

Automatically included in audit report.

TABLE C-3 (cont'd)

Variable name	Description	Units	Range check switch	Missing value indicator	Bounds Lower	Bounds Upper
DPnn	Dew-point temperature	^0C	1	99	-65	35
RHnn	Relative humidity	whole percent	2	999	0	100
V1nn	User's vector #1	user's units	1	999	0	100
V2nn	User's vector #2	user's units	1	999	0	100
V3nn	User's vector #3	user's units	1	999	0	100
ALTP	Altimeter pressure	inches of mercury *100	2	-9999	2700	3200
SLVP*	Sea level pressure	millibars *10	1	-9999	9000	10999
PRES*	Station pressure	millibars *10	1	-9999	9000	10999
CLHT*	Ceiling height	kilometers *10	2	-9999	0	300
TSKC*	Sky cover (total or opaque)	tenths	2	99	0	10
OSDY	Day		2	-9	1	31
OSMO	Month		2	-9	1	12
OSYR	Year		2	-9	0	99
OSHR	Hour		2	-9	0	24
OSMN	Minute		2	-9	0	60

Notes: The nn in variables HT to V3 refers to the level at which the observation was taken; e.g., TT01 is temperature at the first level, WS02 is wind speed at the second level.

The three pressure variables (ALTP, SLVP, and PRES), the ceiling height (CLHT), and the sky cover (TSKC) are also available on the surface pathway.

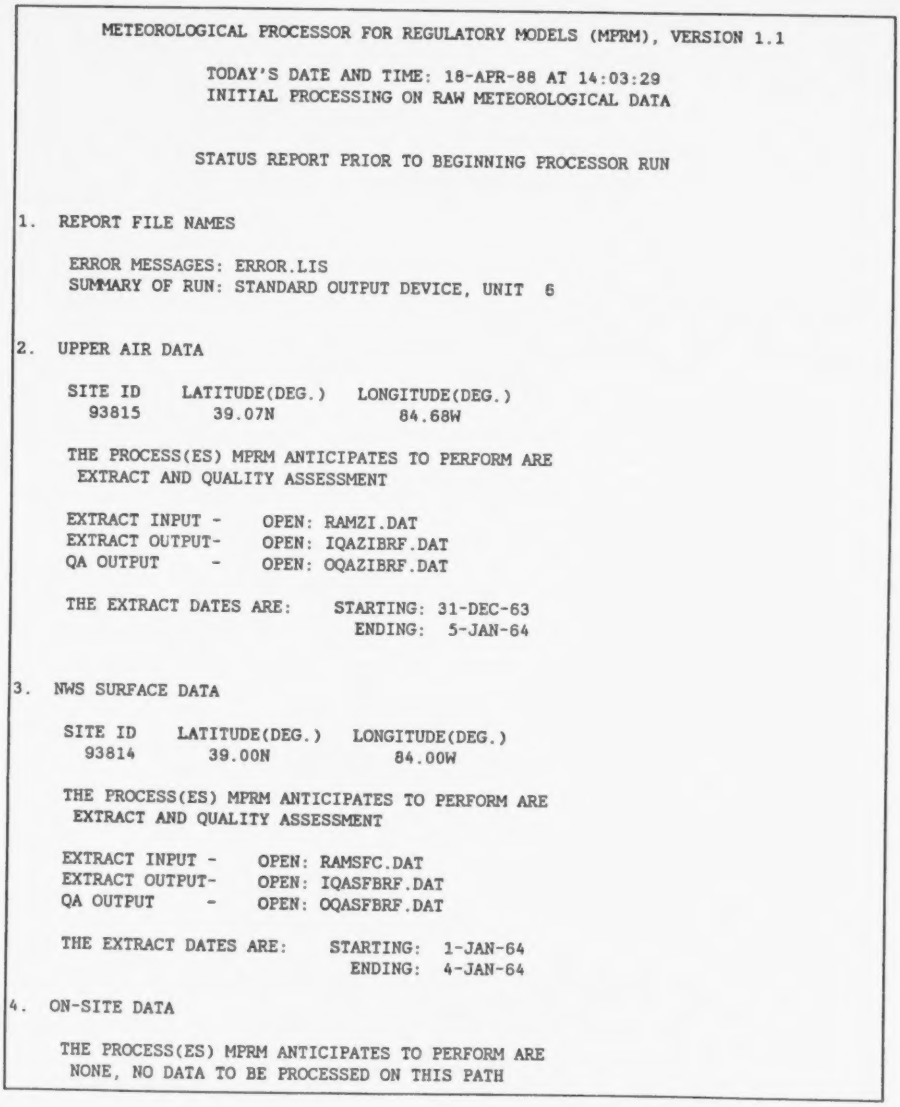
*Automatically included in audit report.

If upper air soundings are to be extracted, an upper height limit is used above which no data are extracted. The default height limit is 5000 meters. The value of the height limit is stored in a variable named UATOP. The user can override this value by specifying a new height on the UA TOP input image for the upper air pathway. A description of this image and its syntax can be found in Appendix B.

NOTE: *The maximum number of levels that can be extracted is set in the processor to 20. If 20 levels of data are extracted and UATOP has not been reached, no additional data are extracted.*

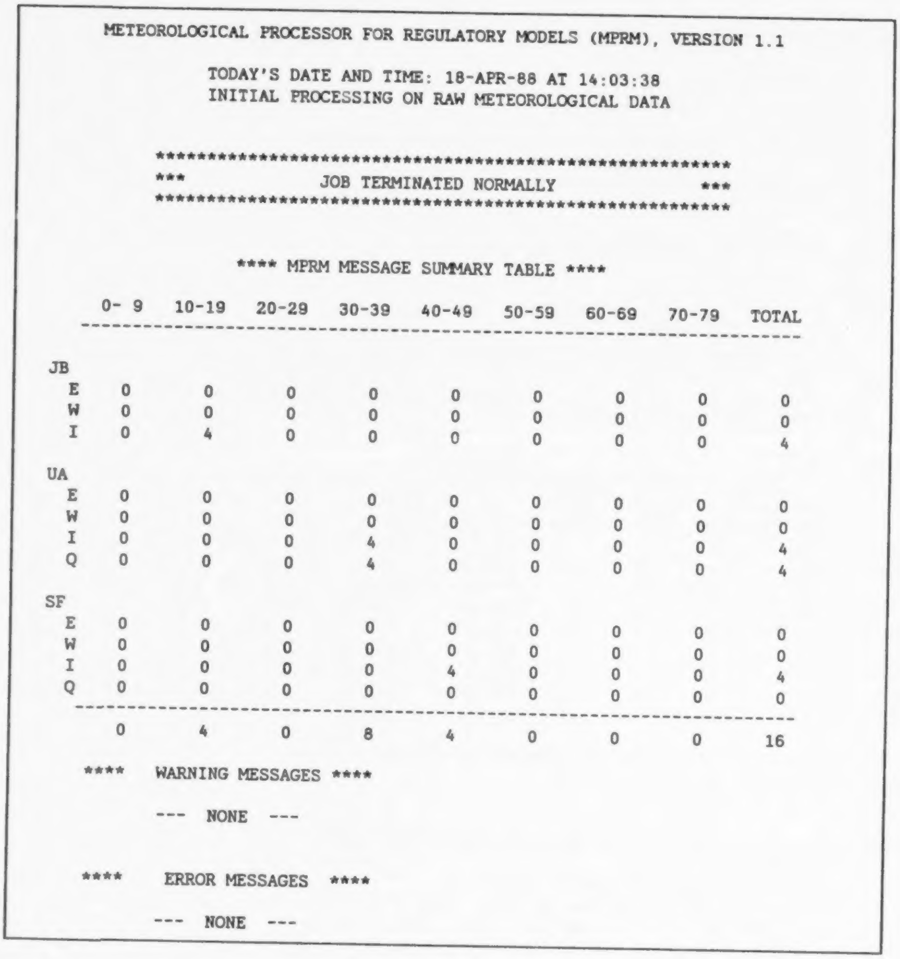
On the OS-pathway there are several default variables having default values that can be redefined by the user through the run stream input data. The number of observations per hour is assumed to be 1. This can be changed via the OS AVG input image. The number can range from 1 to 12. Albedo, Bowen ratio, and surface roughness also have default settings. The default albedo is 0.25 for all months of the year; the default Bowen ratio is 0.75; and the surface roughness length defaults to 0.15 meters for all wind directions and months. All of these can be expanded or modified by using the OS SFC input image. The tutorial in Section 4 and Appendix B have more details on the syntax of these images. The default threshold wind speed for use in definition of calm winds is 1.0 meters/second. This value can be changed with the OS CLM input image.

APPENDIX D
EXAMPLES OF REPORTS



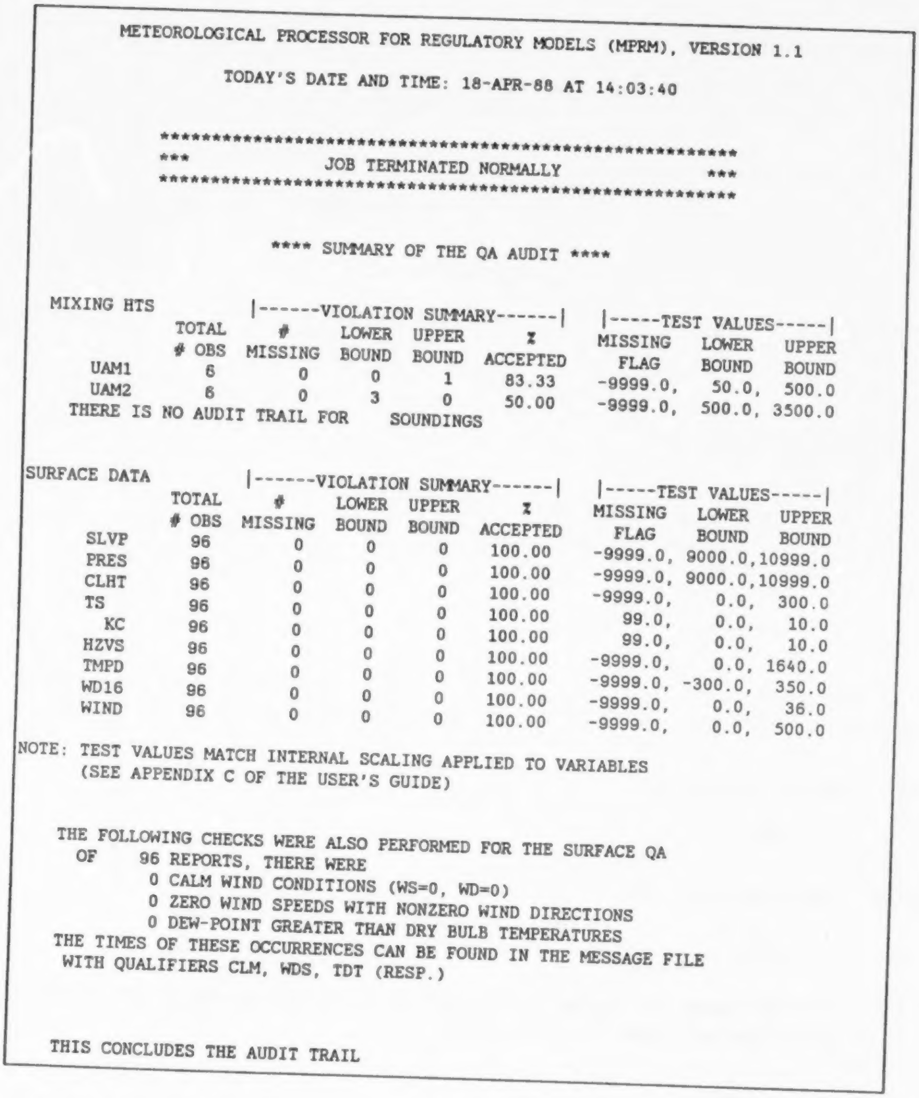
```
        METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                   TODAY'S DATE AND TIME: 18-APR-88 AT 14:03:29
                   INITIAL PROCESSING ON RAW METEOROLOGICAL DATA


                  STATUS REPORT PRIOR TO BEGINNING PROCESSOR RUN


1.  REPORT FILE NAMES

     ERROR MESSAGES: ERROR.LIS
     SUMMARY OF RUN: STANDARD OUTPUT DEVICE, UNIT  6


2.  UPPER AIR DATA

     SITE ID    LATITUDE(DEG.)   LONGITUDE(DEG.)
      93815        39.07N            84.68W

     THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
      EXTRACT AND QUALITY ASSESSMENT

     EXTRACT INPUT -    OPEN: RAMZI.DAT
     EXTRACT OUTPUT-    OPEN: IQAZIBRF.DAT
     QA OUTPUT     -    OPEN: OQAZIBRF.DAT

     THE EXTRACT DATES ARE:     STARTING: 31-DEC-63
                                  ENDING:  5-JAN-64


3.  NWS SURFACE DATA

     SITE ID    LATITUDE(DEG.)   LONGITUDE(DEG.)
      93814        39.00N            84.00W

     THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
      EXTRACT AND QUALITY ASSESSMENT

     EXTRACT INPUT -    OPEN: RAMSFC.DAT
     EXTRACT OUTPUT-    OPEN: IQASFBRF.DAT
     QA OUTPUT     -    OPEN: OQASFBRF.DAT

     THE EXTRACT DATES ARE:     STARTING:  1-JAN-64
                                  ENDING:  4-JAN-64
4.  ON-SITE DATA

     THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
      NONE, NO DATA TO BE PROCESSED ON THIS PATH
```

Figure D-1a. First page of general report for 4-day example of Stage 1 processing used in Tutorial.



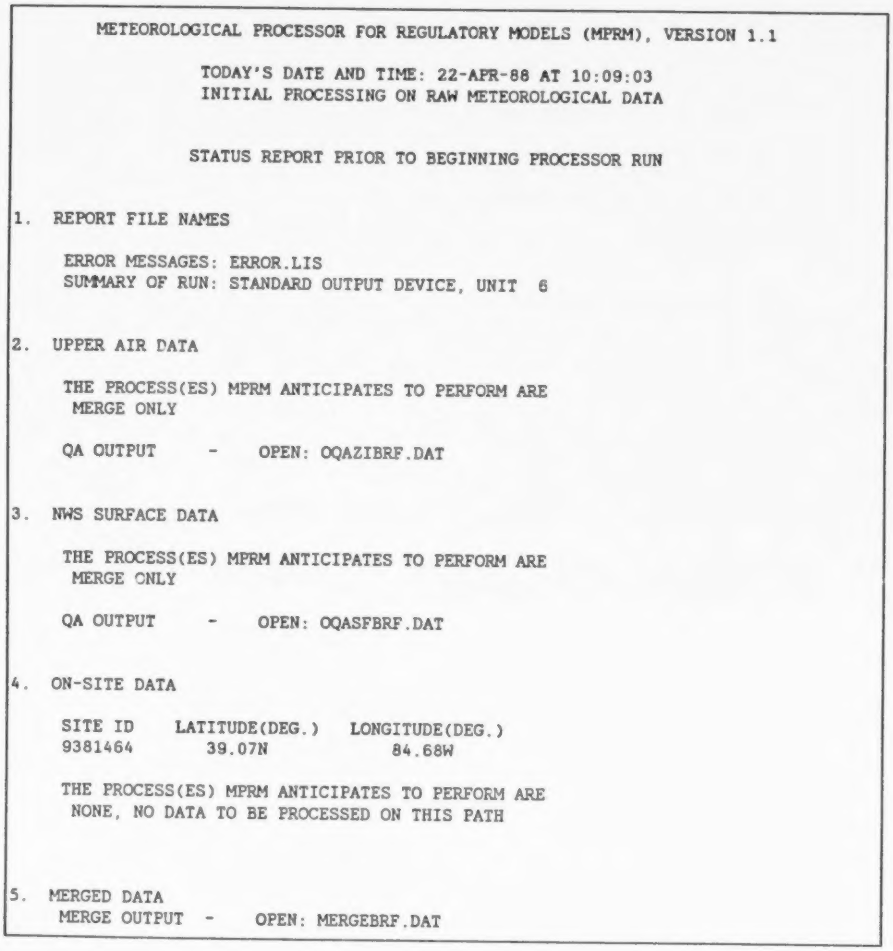
```
        METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                     TODAY'S DATE AND TIME: 18-APR-88 AT 14:03:38
                     INITIAL PROCESSING ON RAW METEOROLOGICAL DATA


              **********************************************************
              ***                JOB TERMINATED NORMALLY             ***
              **********************************************************


                     **** MPRM MESSAGE SUMMARY TABLE ****

        0- 9   10-19   20-29   30-39   40-49   50-59   60-69   70-79   TOTAL
      ---------------------------------------------------------------------

   JB
     E   0      0       0       0       0       0       0       0       0
     W   0      0       0       0       0       0       0       0       0
     I   0      4       0       0       0       0       0       0       4

   UA
     E   0      0       0       0       0       0       0       0       0
     W   0      0       0       0       0       0       0       0       0
     I   0      0       0       4       0       0       0       0       4
     Q   0      0       0       4       0       0       0       0       4

   SF
     E   0      0       0       0       0       0       0       0       0
     W   0      0       0       0       0       0       0       0       0
     I   0      0       0       0       4       0       0       0       4
     Q   0      0       0       0       0       0       0       0       0
      ---------------------------------------------------------------------
         0      4       0       8       4       0       0       0      16

      ****  WARNING MESSAGES ****

            ---  NONE  ---


      ****   ERROR MESSAGES   ****

            ---  NONE  ---
```

Figure D-1b. Second page of general report for 4-day example of Stage 1 processing used in Tutorial.



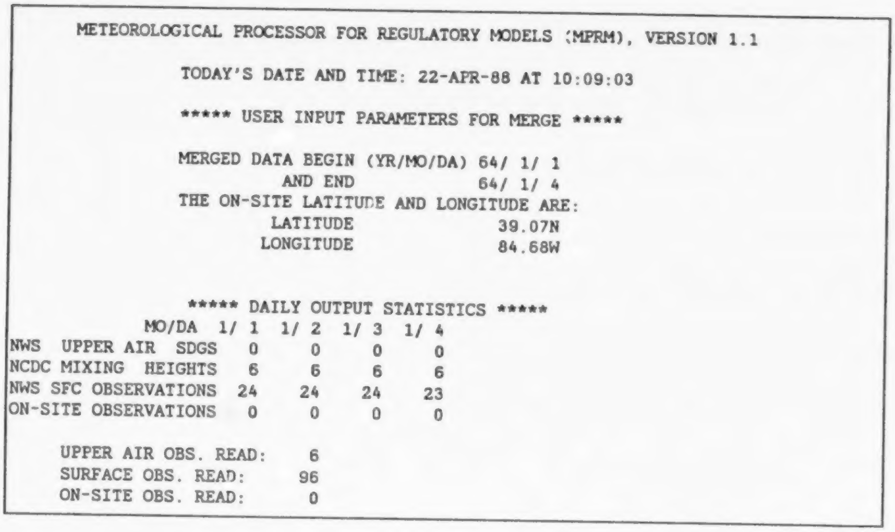
```
          METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                        TODAY'S DATE AND TIME: 18-APR-88 AT 14:03:40

              *******************************************************
              ***              JOB TERMINATED NORMALLY             ***
              *******************************************************


                           **** SUMMARY OF THE QA AUDIT ****

   MIXING HTS            |------VIOLATION SUMMARY------|   |-----TEST VALUES-----|
                 TOTAL       #     LOWER  UPPER      %      MISSING   LOWER   UPPER
                 # OBS  MISSING  BOUND  BOUND  ACCEPTED     FLAG    BOUND   BOUND
       UAM1        6        0      0      1     83.33    -9999.0,   50.0,  500.0
       UAM2        6        0      3      0     50.00    -9999.0,  500.0, 3500.0
     THERE IS NO AUDIT TRAIL FOR     SOUNDINGS

 SURFACE DATA            |------VIOLATION SUMMARY------|   |-----TEST VALUES-----|
                 TOTAL       #     LOWER  UPPER      %      MISSING   LOWER   UPPER
                 # OBS  MISSING  BOUND  BOUND  ACCEPTED     FLAG    BOUND   BOUND
       SLVP       96        0      0      0    100.00    -9999.0, 9000.0,10999.0
       PRES       96        0      0      0    100.00    -9999.0, 9000.0,10999.0
       CLHT       96        0      0      0    100.00    -9999.0,    0.0,  300.0
       TS         96        0      0      0    100.00    -9999.0,    0.0,  300.0
         KC       96        0      0      0    100.00       99.0,    0.0,   10.0
       HZVS       96        0      0      0    100.00       99.0,    0.0,   10.0
       TMPD       96        0      0      0    100.00    -9999.0,    0.0, 1640.0
       WD16       96        0      0      0    100.00    -9999.0, -300.0,  350.0
       WIND       96        0      0      0    100.00    -9999.0,    0.0,   36.0
                                                          -9999.0,    0.0,  500.0
 NOTE: TEST VALUES MATCH INTERNAL SCALING APPLIED TO VARIABLES
       (SEE APPENDIX C OF THE USER'S GUIDE)


     THE FOLLOWING CHECKS WERE ALSO PERFORMED FOR THE SURFACE QA
       OF     96 REPORTS, THERE WERE
                 0 CALM WIND CONDITIONS (WS=0, WD=0)
                 0 ZERO WIND SPEEDS WITH NONZERO WIND DIRECTIONS
                 0 DEW-POINT GREATER THAN DRY BULB TEMPERATURES
     THE TIMES OF THESE OCCURRENCES CAN BE FOUND IN THE MESSAGE FILE
      WITH QUALIFIERS CLM, WDS, TDT (RESP.)


     THIS CONCLUDES THE AUDIT TRAIL
```

Figure D-1c. Third page of general report for 4-day example of Stage 1 processing used in Tutorial.



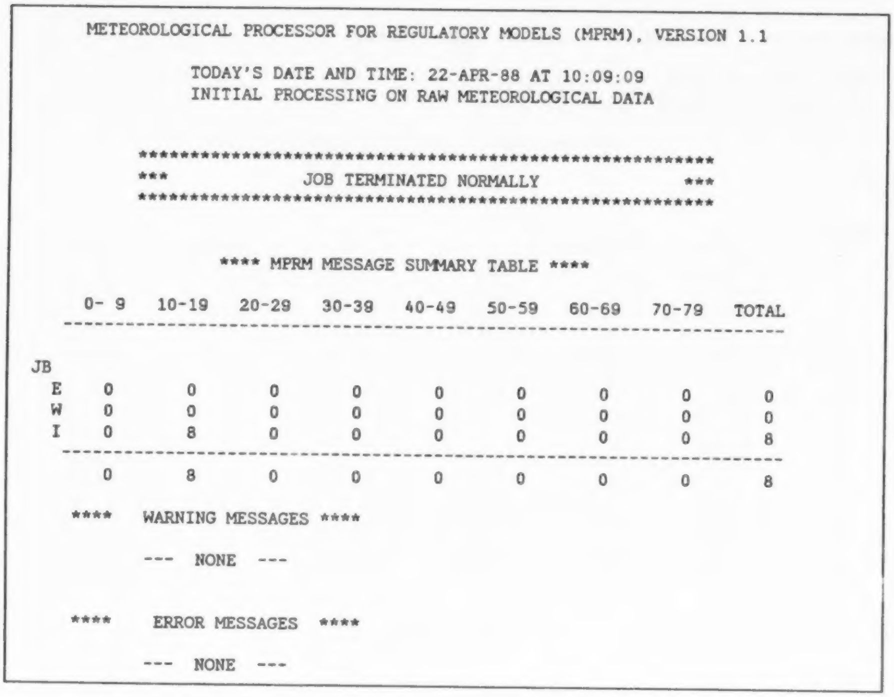
```
        METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                   TODAY'S DATE AND TIME: 22-APR-88 AT 10:09:03
                   INITIAL PROCESSING ON RAW METEOROLOGICAL DATA


                  STATUS REPORT PRIOR TO BEGINNING PROCESSOR RUN

1.  REPORT FILE NAMES

     ERROR MESSAGES: ERROR.LIS
     SUMMARY OF RUN: STANDARD OUTPUT DEVICE, UNIT  6

2.  UPPER AIR DATA

     THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
      MERGE ONLY

     QA OUTPUT     -    OPEN: OQAZIBRF.DAT

3.  NWS SURFACE DATA

     THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
      MERGE ONLY

     QA OUTPUT     -    OPEN: OQASFBRF.DAT

4.  ON-SITE DATA

     SITE ID    LATITUDE(DEG.)   LONGITUDE(DEG.)
     9381464       39.07N            84.68W

     THE PROCESS(ES) MPRM ANTICIPATES TO PERFORM ARE
      NONE, NO DATA TO BE PROCESSED ON THIS PATH


5.  MERGED DATA
     MERGE OUTPUT  -    OPEN: MERGEBRF.DAT
```

Figure D-2a. First page of general report for 4-day example of Stage 2 processing used in Tutorial.



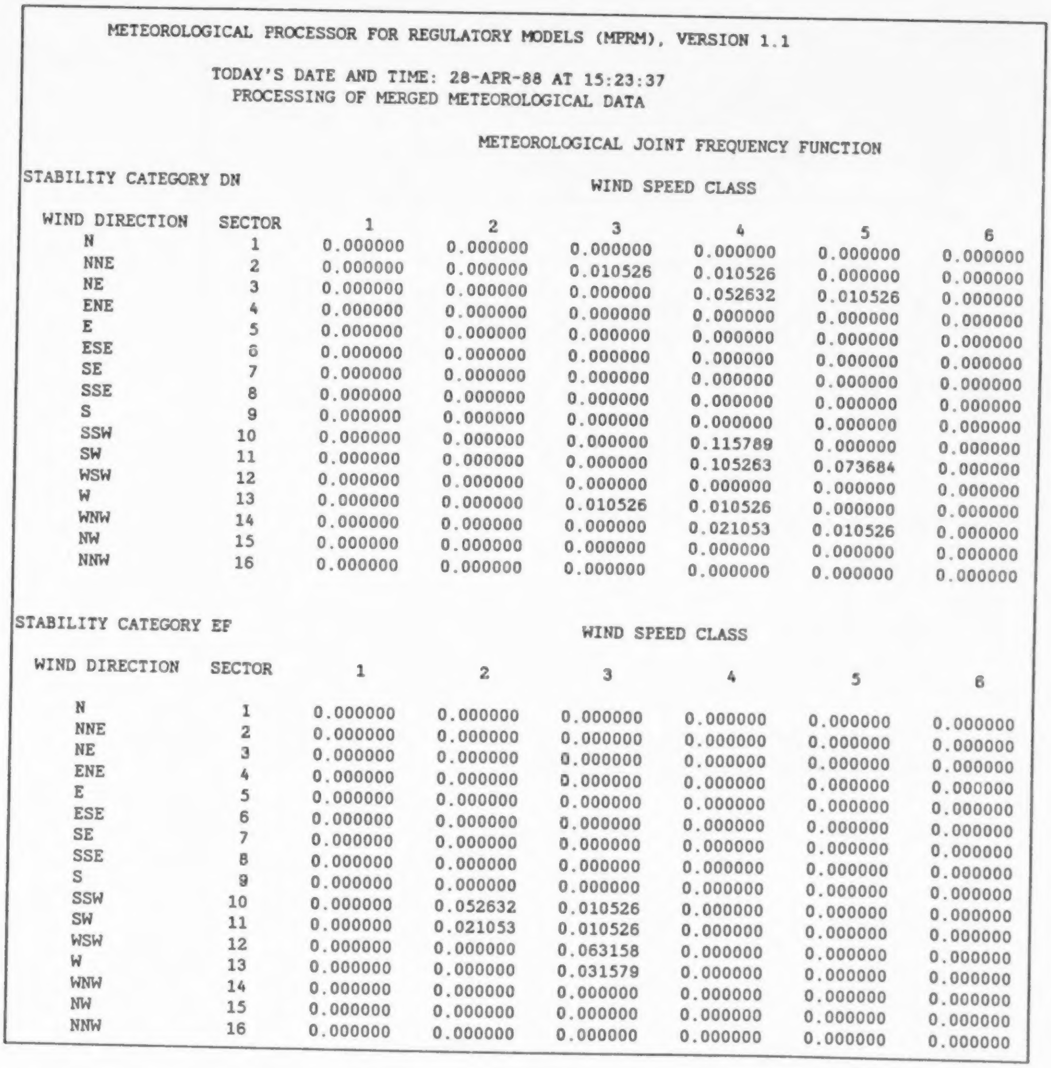
```
      METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                 TODAY'S DATE AND TIME: 22-APR-88 AT 10:09:03

                 ***** USER INPUT PARAMETERS FOR MERGE *****

                 MERGED DATA BEGIN (YR/MO/DA) 64/ 1/ 1
                            AND END           64/ 1/ 4
                 THE ON-SITE LATITUDE AND LONGITUDE ARE:
                           LATITUDE             39.07N
                          LONGITUDE             84.68W


                  ***** DAILY OUTPUT STATISTICS *****
             MO/DA  1/ 1  1/ 2  1/ 3  1/ 4
NWS  UPPER AIR  SDGS   0     0     0     0
NCDC MIXING  HEIGHTS   6     6     6     6
NWS SFC OBSERVATIONS  24    24    24    23
ON-SITE OBSERVATIONS   0     0     0     0

        UPPER AIR OBS. READ:     6
        SURFACE OBS. READ:      96
        ON-SITE OBS. READ:       0
```

Figure D-2b. Second page of general report for 4-day example of Stage 2 processing used in Tutorial.



```
        METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                     TODAY'S DATE AND TIME: 22-APR-88 AT 10:09:09
                     INITIAL PROCESSING ON RAW METEOROLOGICAL DATA


             *********************************************************
             ***               JOB TERMINATED NORMALLY             ***
             *********************************************************


                         **** MPRM MESSAGE SUMMARY TABLE ****

        0- 9   10-19   20-29   30-39   40-49   50-59   60-69   70-79   TOTAL
      ----------------------------------------------------------------------

 JB
   E    0       0       0       0       0       0       0       0       0
   W    0       0       0       0       0       0       0       0       0
   I    0       8       0       0       0       0       0       0       8
      ----------------------------------------------------------------------
        0       8       0       0       0       0       0       0       8

      ****  WARNING MESSAGES ****

            ---  NONE  ---


      ****   ERROR MESSAGES  ****

            ---  NONE  ---
```

Figure D-2c. Third page of general report for 4-day example of Stage 2 processing used in Tutorial.

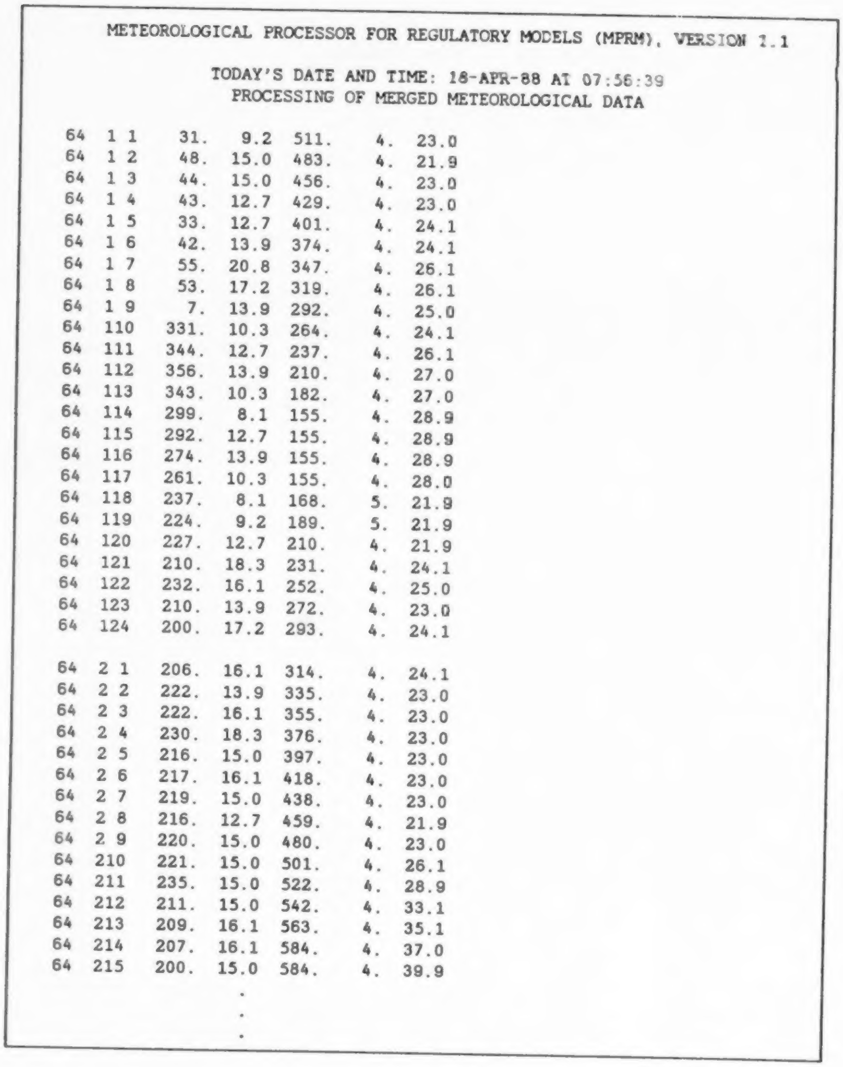


```
          METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                     TODAY'S DATE AND TIME: 28-APR-88 AT 15:23:37
                       PROCESSING OF MERGED METEOROLOGICAL DATA

                                         METEOROLOGICAL JOINT FREQUENCY FUNCTION

STABILITY CATEGORY DN                                WIND SPEED CLASS

  WIND DIRECTION   SECTOR      1          2          3          4          5          6
       N              1     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       NNE            2     0.000000   0.000000   0.010526   0.010526   0.000000   0.000000
       NE             3     0.000000   0.000000   0.000000   0.052632   0.010526   0.000000
       ENE            4     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       E              5     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       ESE            6     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       SE             7     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       SSE            8     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       S              9     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       SSW           10     0.000000   0.000000   0.000000   0.115789   0.000000   0.000000
       SW            11     0.000000   0.000000   0.000000   0.105263   0.073684   0.000000
       WSW           12     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       W             13     0.000000   0.000000   0.010526   0.010526   0.000000   0.000000
       WNW           14     0.000000   0.000000   0.000000   0.021053   0.010526   0.000000
       NW            15     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       NNW           16     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000

STABILITY CATEGORY EF                                WIND SPEED CLASS

  WIND DIRECTION   SECTOR      1          2          3          4          5          6

       N              1     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       NNE            2     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       NE             3     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       ENE            4     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       E              5     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       ESE            6     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       SE             7     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       SSE            8     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       S              9     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       SSW           10     0.000000   0.052632   0.010526   0.000000   0.000000   0.000000
       SW            11     0.000000   0.021053   0.010526   0.000000   0.000000   0.000000
       WSW           12     0.000000   0.000000   0.063158   0.000000   0.000000   0.000000
       W             13     0.000000   0.000000   0.031579   0.000000   0.000000   0.000000
       WNW           14     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       NW            15     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
       NNW           16     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
```

Figure D-3a. Portion of listing of meteorological data generated for the CDM16 dispersion model from Stage 3 processing (4-day example for Tutorial).

```
        METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                 TODAY'S DATE AND TIME: 18-APR-88 AT 07:56:03
                  PROCESSING OF MERGED METEOROLOGICAL DATA

                                        METEOROLOGICAL JOINT FREQUENCY FUNCTION

STABILITY CATEGORY DN
                                                    WIND SPEED CLASS

  WIND DIRECTION   SECTOR      1          2          3          4          5          6

     355-005          1     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     005-015          2     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     015-025          3     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     025-035          4     0.000000   0.000000   0.010526   0.010526   0.000000   0.000000
     035-045          5     0.000000   0.000000   0.000000   0.031579   0.000000   0.000000
     045-055          6     0.000000   0.000000   0.000000   0.021053   0.000000   0.000000
     055-065          7     0.000000   0.000000   0.000000   0.000000   0.010526   0.000000
     065-075          8     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     075-085          9     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     085-095         10     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     095-105         11     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     105-115         12     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     115-125         13     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     125-135         14     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     135-145         15     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     145-155         16     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     155-165         17     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     165-175         18     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     175-185         19     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     185-195         20     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     195-205         21     0.000000   0.000000   0.000000   0.031579   0.000000   0.000000
     205-215         22     0.000000   0.000000   0.000000   0.084211   0.010526   0.000000
     215-225         23     0.000000   0.000000   0.000000   0.073684   0.063158   0.000000
     225-235         24     0.000000   0.000000   0.000000   0.031579   0.000000   0.000000
     235-245         25     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     245-255         26     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     255-265         27     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     265-275         28     0.000000   0.000000   0.010526   0.010526   0.000000   0.000000
     275-285         29     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     285-295         30     0.000000   0.000000   0.000000   0.021053   0.010526   0.000000
     295-305         31     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     305-315         32     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     315-325         33     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     325-335         34     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     335-345         35     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
     345-355         36     0.000000   0.000000   0.000000   0.000000   0.000000   0.000000
```

Figure D-3b. Portion of listing of meteorological data generated for the CDM36 dispersion model from Stage 3 processing (4-day example for Tutorial).



```
          METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                     TODAY'S DATE AND TIME: 18-APR-88 AT 07:56:39
                       PROCESSING OF MERGED METEOROLOGICAL DATA

   64  1 1    31.   9.2  511.     4.  23.0
   64  1 2    48.  15.0  483.     4.  21.9
   64  1 3    44.  15.0  456.     4.  23.0
   64  1 4    43.  12.7  429.     4.  23.0
   64  1 5    33.  12.7  401.     4.  24.1
   64  1 6    42.  13.9  374.     4.  24.1
   64  1 7    55.  20.8  347.     4.  26.1
   64  1 8    53.  17.2  319.     4.  26.1
   64  1 9     7.  13.9  292.     4.  25.0
   64  110   331.  10.3  264.     4.  24.1
   64  111   344.  12.7  237.     4.  26.1
   64  112   356.  13.9  210.     4.  27.0
   64  113   343.  10.3  182.     4.  27.0
   64  114   299.   8.1  155.     4.  28.9
   64  115   292.  12.7  155.     4.  28.9
   64  116   274.  13.9  155.     4.  28.9
   64  117   261.  10.3  155.     4.  28.0
   64  118   237.   8.1  168.     5.  21.9
   64  119   224.   9.2  189.     5.  21.9
   64  120   227.  12.7  210.     4.  21.9
   64  121   210.  18.3  231.     4.  24.1
   64  122   232.  16.1  252.     4.  25.0
   64  123   210.  13.9  272.     4.  23.0
   64  124   200.  17.2  293.     4.  24.1

   64  2 1   206.  16.1  314.     4.  24.1
   64  2 2   222.  13.9  335.     4.  23.0
   64  2 3   222.  16.1  355.     4.  23.0
   64  2 4   230.  18.3  376.     4.  23.0
   64  2 5   216.  15.0  397.     4.  23.0
   64  2 6   217.  16.1  418.     4.  23.0
   64  2 7   219.  15.0  438.     4.  23.0
   64  2 8   216.  12.7  459.     4.  21.9
   64  2 9   220.  15.0  480.     4.  23.0
   64  210   221.  15.0  501.     4.  26.1
   64  211   235.  15.0  522.     4.  28.9
   64  212   211.  15.0  542.     4.  33.1
   64  213   209.  16.1  563.     4.  35.1
   64  214   207.  16.1  584.     4.  37.0
   64  215   200.  15.0  584.     4.  39.9
                      .
                      .
                      .
```

Figure D-3c. Portion of listing of meteorological data generated for the RTDM dispersion model from Stage 3 processing (4-day example for Tutorial).

```
      METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM), VERSION 1.1

                    TODAY'S DATE AND TIME: 18-APR-88 AT 07:58:02
                      PROCESSING OF MERGED METEOROLOGICAL DATA

  64   1 1    4.1  31.0  4 1000.0    0.0
  64   1 2    6.7  48.0  4 1000.0    0.0
  64   1 3    6.7  44.0  4 1000.0    0.0
  64   1 4    5.7  43.0  4 1000.0    0.0
  64   1 5    5.7  33.0  4 1000.0    0.0
  64   1 6    6.2  42.0  4 1000.0    0.0
  64   1 7    9.3  55.0  4 1000.0    0.0
  64   1 8    7.7  53.0  4 1000.0    0.0
  64   1 9    6.2   7.0  4 1000.0    0.0
  64   110    4.6 331.0  4 1000.0    0.0
  64   111    5.7 344.0  4 1000.0    0.0
  64   112    6.2 356.0  4 1000.0    0.0
  64   113    4.6 343.0  4 1000.0    0.0
  64   114    3.6 299.0  4 1000.0    0.0
  64   115    5.7 292.0  4 1000.0    0.0
  64   116    6.2 274.0  4 1000.0    0.0
  64   117    4.6 261.0  4 1000.0    0.0
  64   118    3.6 237.0  5 1000.0    0.0
  64   119    4.1 224.0  5 1000.0    0.0
  64   120    5.7 227.0  4 1000.0    0.0
  64   121    8.2 210.0  4 1000.0    0.0
  64   122    7.2 232.0  4 1000.0    0.0
  64   123    6.2 210.0  4 1000.0    0.0
  64   124    7.7 200.0  4 1000.0    0.0

  64   2 1    7.2 206.0  4 1000.0    0.0
  64   2 2    6.2 222.0  4 1000.0    0.0
  64   2 3    7.2 222.0  4 1000.0    0.0
  64   2 4    8.2 230.0  4 1000.0    0.0
  64   2 5    6.7 216.0  4 1000.0    0.0
  64   2 6    7.2 217.0  4 1000.0    0.0
  64   2 7    6.7 219.0  4 1000.0    0.0
  64   2 8    5.7 216.0  4 1000.0    0.0
  64   2 9    6.7 220.0  4 1000.0    0.0
  64   210    6.7 221.0  4 1000.0    0.0
  64   211    6.7 235.0  4 1000.0    0.0
  64   212    6.7 211.0  4 1000.0    0.0
  64   213    7.2 209.0  4 1000.0    0.0
  64   214    7.2 207.0  4 1000.0    0.0
  64   215    6.7 200.0  4 1000.0    0.0
  64   216    7.2 204.0  4 1000.0    0.0
  64   217    8.2 198.0  4 1000.0    0.0
  64   218    6.2 201.0  4 1000.0    0.0
  64   219    6.7 202.0  4 1000.0    0.0
  64   220    6.2 205.0  4 1000.0    0.0
  64   221    8.8 214.0  4 1000.0    0.0
  64   222    9.3 215.0  4 1000.0    0.0
  64   223    9.8 217.0  4 1000.0    0.0
                     .
                     .
                     .
```

Figure D-3d. Portion of listing of meteorological data generated for the CALINE-3 dispersion model from Stage 3 processing (4-day example for Tutorial).

```
 13 JB I19  SETUP: ENCOUNTERED END OF "JOB/RUN CARD"
  0 JB W12 UAQAST: SUMMARY: MISSING/ERRORS IN UA-OQA CARD
  0 JB I10   TEST: SUMMARY: NO SF-EXT CARD, NULL EXTRACT
  0 JB I11   TEST: SUMMARY: NO SF-IQA CARD, NULL QA
  0 JB I12   TEST: SUMMARY: NO SF-OQA CARD, NULL MERGE
  0 JB I10   TEST: SUMMARY: NO OS-EXT CARD, NULL EXTRACT
  0 JB I11   TEST: SUMMARY: NO OS-IQA CARD, NULL QA
  0 JB I12   TEST: SUMMARY: NO OS-OQA CARD, NULL MERGE
  0 UA I30  UAEXT: **** UPPER AIR EXTRACTION ****
  0 UA I36  UAEXT:*      *** AUTOMATIC SDG. CHECKS ARE ON
  0 UA I39 GETSDG: END-OF-FILE, END-OF-DATA
  0 UA W38 GETSDG: NO OBS. RETRIEVED; SEE UNIT 60 FOR SCAN
  0 UA I39 GETMIX: END-OF-FILE, END-OF-DATA
  0 UA W38 GETMIX: NO OBS RETRIEVED-CHECK INPUT STN/DATES
  0 UA I30  UAEXT:    0 SDGS AND     0 MIXING HTS EXTRACTED



TAPE CONTENTS FOR UNIT  10, FILE:TAPE10
                    FROM                      TO
     STATION   YR MO DA HR JDAY       MO DA HR JDAY
     13840     64  1  1  0    1       12 31 12  366
     13840     65  1  3  0    3       12 30 12  364
     13840     66  1  2  0    2       12 31 12  365
     13840     67  1  3 12    3       12 30  0  364
     13840     68  1  1 12    1       12 30 12  365
     13840     69  1  2  0    2       12 31 12  365
     13840     70  1  3  0    3       12 30 12  364
```

Figure D-4. Listing of an error/message file for Stage 1 processing with a report of tape contents for NWS upper air data. Tape contents are reported only if the specified station and dates are not located.

APPENDIX E

SUMMARY OF ERROR AND WARNING MESSAGES

During processing of the input images and the data, the processor writes messages to the error/message file defined in the JB ERR input image (see Appendix B for a description of this image). Five types of messages can be generated:

- An error that stops the processor from completing the original request for data processing; considered a fatal error
- An error that may not stop processing
- Status of the processing
- Quality assessment violation
- A computation could not be performed during Stage 3 processing AND the trace option is on.

A message from the processor has the form:

N PP $a_1a_2a_3$ SSSSSS: message

More detailed description of the message code (up to 40 characters)

Subroutine from which the message is generated

Alphanumeric message code

Pathway ID (JB, UA, SF, OS, MR, MP)

Counter

The message code is composed of two parts - a leading alphabetic character and a trailing 2-digit code. The alphabetic character (a_1 above) can be:

E fatal error; if the error occurs during processing of of input images, the remainder of the images are processed to locate other possible problems with the images; if the error occurs during processing of data on a pathway, processing ceases on that pathway and the next step defined by the input images begins

W warning; further data processing may or may not be prohibited depending on the processing requested through the input images;

I information on the status of the processing - these messages monitor the progress of a processor run;

Q quality assessment violation - a value for a variable was outside the interval defined by the upper and lower bounds;

T an hourly computation could not be performed during Stage 3 processing AND the hourly trace key was turned on using the input image MP TRA.

The 2-digit codes (a_2a_3 in the message code) are grouped into general categories corresponding to the processing in Stages 1, 2, and 3. These categories are

00 - 19	Input image processing
20 - 29	File header and library processing
30 - 39	Upper air soundings and mixing heights processing
40 - 49	Surface observations processing
50 - 59	On-site observations processing
60 - 69	Merge processing
70 - 79	Stage 3 processing
**	program trap - there is an error in program logic; the processor stops immediately

Within the general categories are codes pertaining to processing in MPRM. These codes are more specific than the general categories but do not completely specify the reason for the message. That is left to the 40-character message. The codes are summarized by pathway and severity and category at the end of each processor run in a table that is written to the file defined by the JB OUT input image or, if this image is omitted, the default output device. The MPRM processor uses device number (logical unit) 6 for this purpose.

INPUT IMAGE PROCESSING, 00 - 19

If an error is detected on an input image, a message is written to the message file and any attempt to process data is prohibited. If a warning occurs, data may or may not be processed, depending on the processing requirements specified within the run stream input data. For example, a warning with a message code of W12 is written if there is no IQA image on a pathway. If it is detected that the user wants to extract data, processing will be halted as there is not output file (defined by use of the IQA input) for the extracted data.

E00	A keyword field is blank
E01	Repeated keyword/Improper keyword
E02	Error reading an input image
E03	Error decoding a field on an input image
E04	Incomplete or superfluous information on an input image
E05	Error in a field - a keyword could not be determined
E06	A value or character is not within bounds or is unreasonable; improper information specified in a field; no match with allowable names (see also code W06 below)
E07	Error opening a tape or file; file not open; the file name was specified for more than one device (logical unit) number
E10	Fatal write error to the temporary file
E11	Pathway status (status = -1) does not allow further processing
E12	Unable to proceed; previous errors on a pathway card (from subroutine COMPLETE)
E13	The on-site data map and formats were not specified
E14	An attempt was made to change a previously established value for Stage 3 processing

W00	A blank image was encountered in the input images
W06	Value on an input card image may not be reasonable (see also code E06 above)
W10	Non-fatal write error writing to the temporary file
W12	Missing/errors on an input image - may or may not be fatal depending on the processing requested

W15	Audit disabled for the on-site variable specified

I10	No extraction on the pathway specified
I11	No quality assessment on the pathway specified
I12	No file on the pathway specified to merge
I19	End-of-file or JB END card encountered

FILE HEADER AND LIBRARY PROCESSING, 20 - 29

Any messages that pertain to writing file headers during the initial processing or messages issued by the library routines (those routines accessed by more than one subroutine) are in this category.

E20	Header read error
E21	Header write error
E22	From subroutine FLHEAD: there were errors on the input file, so there are no data to process
E23	From subroutine FLHEAD: error reading the headers placed in the output file by input image processing
E24	From subroutines CHROND or ICHRND: there were problems in computing the chronological day from year, month and day, or computing the year, month and day from the chronological day; the subroutine that generates the message is identified

W22	From subroutine FLHEAD: An end-of-file was encountered reading the headers on an input file, there is no processing of data from this pathway

I23	From subroutine FLHEAD: an end-of-file reading the headers from the output file - a correct condition

UPPER AIR PROCESSING, 30 - 39

Any messages that pertain to the upper air pathway, and issued after the input images are processed, are in this category.

E32	There is an error reading or decoding the data and the count now exceeds the maximum number of errors allowed
E35	Data blocking type specified incorrectly - allowable specifications are VB (variable block) and FB (fixed block)
E36	Error reading the file headers during quality assessment - no data processed
W32	There is an error reading or decoding the data and the count is less than the maximum number allowed - processing continues
W33	Sounding surface height is less than zero; the height is set to zero
W38	No soundings or mixing heights were retrieved because there was no match found in the data with the station ID specified in the run stream input.
I30	A message indicating that the point has been reached where processing of the UA-data can begin
I31	Automatic data modification for upper air soundings is enabled (see section 6 for a discussion of these modifications)
I32	No data were extracted; a report of the tape/file contents is written to the error/message file

I37	A mixing height quality assessment lower bound violation; this message code is written for the second and subsequent encounters of the mixing heights within a day
I38	A mixing height quality assessment upper bound violation; this message code is written for the second and subsequent encounters of the mixing heights within a day
I39	An end-of-file was encountered on the input file in the expected position in the file

Q34	The vertical gradients cannot be computed at one or more heights because one or more heights are missing
Q35	The sounding height is not in any of the height intervals defined for the upper air audit; the processor STOPS immediately and the last message in the message file will identify the location of the problem; neither a summary table nor an audit table is generated
Q36	From subroutine HTCALC: the heights have not been recomputed due to missing data
Q37	A lower bound quality assessment violation
Q38	An upper bound quality assessment violation

SURFACE OBSERVATIONS PROCESSING, 40 - 49

Any messages that pertain to the surface pathway, and issued after the input images are processed, are in this category.

E42	There is an error reading or decoding the data and the count now exceeds the maximum number of errors allowed
E46	Error reading the file headers during quality assessment - no data processed

W42	There is an error reading or decoding the data and the count is less than the maximum number allowed - processing continues
W43	There is an error decoding an over-punch character; the missing value indicator for that variable will be inserted into the output file
W48	No surface observations were retrieved because there was no match found in the data with the station ID specified in the run stream input.

I40	A message indicating that the point has been reached that processing of the SF-data can begin
I48	No data were extracted; a report of the tape/file contents is written to the error/message file
I49	An end-of-file was encountered on the input file in the expected position in the file

Q47	A lower bound quality assessment violation
Q48	An upper bound quality assessment violation

ON-SITE OBSERVATIONS PROCESSING, 50 - 59

Any messages that pertain to the on-site pathway, and issued after the input images are processed, are in this category.

E50	There is an error reading an input file header
E51	There is an error writing an input file header to the output file
E52	There is an error reading or decoding the data and the count now exceeds the maximum number of errors allowed

E53	There is an error writing data to the output file
E54	The observations are not sequential in time
E55	The number of observations exceeds the number expected for the hour, defined as 1 (default) or on the input image OS AVG (note maximum of 12 allowed)
E56	An end-of-file on the input data was encountered before one complete observation was read

W52	There is an error reading the data and the count is less than the maximum number allowed - processing continues

I57	An intra-hour observation violated a quality assessment lower bound
I58	An intra-hour observation violated a quality assessment upper bound
I59	An end-of-file was encountered on the input file in the expected position in the file

Q57	Lower bound quality assessment violation
Q58	Upper bound quality assessment violation

MERGE PROCESSING, 60 - 69

Any messages pertaining to combining the three data types (merge), and issued after the input images are processed, are in this category.

E60	There is an error computing the chronological day from Julian day and year
E61	There is an error computing the Julian day and year from the chronological day
E62	There is an error reading the upper air data
E63	There is an error reading the surface data

E64	There is an error reading the on-site data
E65	There is an error writing the on-site data to the output file
E66	There is an error processing an input file's header cards
E67	No chronological days for merging were computed

I67	The beginning chronological day is computed from the earliest available date on the three pathways; the ending chronological day = beginning day + 367. This message is generated if no MR EXT input is defined.

STAGE 3 PROCESSING, 70 - 79

Any messages that pertain to Stage 3 processing, and issued after the input images are processed, are in this category.

E70	The preliminary processing (such as the latitude and longitude) has produced an error; the input file has no data; the 40-character message further identifies the source of the error
E71	There is an error reading the input data; the data are not a 1 - 24 hour clock; the hour for on-site data is represented by the missing value indicator

W70	During preliminary processing, a value does not appear correct (e.g., the GMT to LST conversion factor); hour 23 data have been swapped in for hour 24 data for the surface pathway
W72	The mixing heights were not computed for the specified number of hours
W73	The temperatures cannot be determined for the specified number of hours

W74	The winds cannot be determined for the specified number of hours
W75	The stability categories cannot be determined for the specified number of hours
W76	The surface roughness length cannot be determined for the number of hours specified
I70	End of header group reached on input file
I71	Station location for pathway changed from characters to 0 (zero) to conform to RAMMET output specifications
I75	Missing data has resulted in use of an alternate estimation scheme for stability, the alternate scheme is reported in message
I79	The end of the processing window, defined by the JB EXT image, was encountered or, if no window was specified, the end-of-file was encountered

The following are written only if the JB TRA image is present for Stage 3 processing

T72	The mixing height cannot be computed for the specified hour
T73	The temperature cannot be determined for the specified hour
T74	The winds cannot be determined for the specified hour
T75	The stability category cannot be computed for the specified hour and methodology
T76	The surface roughness length cannot be determined for the specified hour

APPENDIX F

FORMAT OF DATA FILES

The upper air and surface observations are written in a specific format after the data are extracted. These formats are retained for the remainder of the processing until the merging of the data (Stage 2 processing). Because the user specifies the data map (format) of the on-site data, this discussion does not apply to the on-site data.

The format of meteorological data files generated by Stage 3 processing are specific to the dispersion models. Details regarding the format should be obtained from the respective user's guides. A brief summary of the format is provided for informational purposes.

UPPER AIR

An extracted upper air data report is composed of two parts:

- A header record consisting of a year, month, day, hour group, the number of sounding levels, and the morning and evening mixing heights

- Sounding data, if soundings were extracted, consisting of a pressure, height above ground level, temperature, dew-point temperature, wind speed, and wind direction.

In the READ statements that accompany the FORMAT statements below, u refers to the device (logical unit) number and f refers to the format statement number. The variable names are also shown for those variables that appear in Appendix C. The names given for the date/time group and the number of levels in an upper air sounding are generic names and do not correspond to any of the names in Appendix C.

The format of the header record is:

```
READ(u,f)      yr, mo, da, hr, lev, UAM1,  UAM2
FORMAT    (1X, I2, I2, I2, I2, I5, 1X,I5, 1X,I5)
```

year (2-digit)

month

day

hour of the observation in Local Standard Time (LST) (the hour is set to 12 if only mixing heights are extracted)

# of sounding levels in this report (this number is 0 if no soundings were extracted or there are no levels of data)

a.m. mixing height (meters)

p.m. mixing height (meters)

The format of the levels of data, if they exist, is

```
READ (u,f) UAPR,  UAHT,  UATT,  UATD,  UAWD,  UAWS
FORMAT   (1X,I5, 1X,I5, 1X,I5, 1X,I5, 1X,I5, 1X,I5)
```

*atmospheric pressure (millibars)**

height above ground level (AGL) (meters)

*dry bulb temperature (degrees Celsius)**

*dew-point temperature (degrees Celsius)**

wind direction (tens of degrees from north)

*wind speed (meters/second)**

All values on the upper air pathway are written as integers. The asterisk (*) following four of the descriptions above indicate that the values were multiplied by 10 to retain one significant digit after the decimal point prior to rounding the result to the nearest whole number.

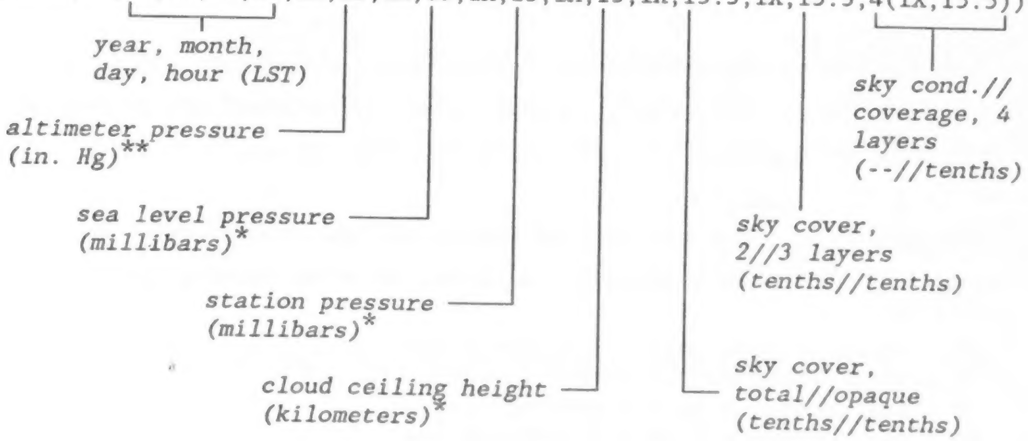
The READ uses 4-character names to identify the variables. Tables of these names with the default parameters are in Appendix C.

SURFACE OBSERVATIONS

Each hourly surface observation is written as two records. As with the upper air data, all values are reported as integers with several variables being multiplied by 10 or 100 to retain significant digits. Several of the variables are two variables combined to form one integer value. These are recognized by the // in the variable name and units below. The single asterisk next to the units indicates that the value written to the output file is multiplied by 10; the double asterisk next to the altimeter pressure indicates that the value is multiplied by 100.

The format of the first record of the surface observations is

```
READ(u,f) yr,mo,da,hr,ALTP,SLVP,PRES,CLHT,TSKC,C2C3,CLC1,CLC2,CLC3,CLC4
FORMAT(1X,I2,I2,I2,I2,1X,I5,1X,I5,1X,I5,1X,I5,1X,I5.5,1X,I5.5,4(1X,I5.5))
```


year, month,
day, hour (LST)
altimeter pressure
(in. Hg)**
sea level pressure
(millibars)*
station pressure
(millibars)*
cloud ceiling height
(kilometers)*
sky cond.//
coverage, 4
layers
(--//tenths)
sky cover,
2//3 layers
(tenths//tenths)
sky cover,
total//opaque
(tenths//tenths)

The format of the second record of the surface observations is

```
READ (u,f) CLT1,CLT2,CLT3,CLT4,PWTH,HZVS,TMPD,TMPW,DPTP,RHUM,WD16,WIND
FORMAT(8X,4(1X,I5.5),1X,I5.5,1X,I5,1X,I5,1X,I5,1X,I5,1X,I5,1X,I5,1X,I5)
```

cloud type//height,
4 layers
*(---//kilometers)**

present weather,
2 types - (no units)

horizontal visibility
*(kilometers)**

dry bulb temperature
*(degrees Celsius)**

wet bulb temperature
*(degrees Celsius)**

dew-point
temperature
*(degrees Celsius)**

relative
humidity
(percent)

wind direction
(tens of degrees
from north)

wind speed
(meters/
*second)**

All reports of sky conditions, cloud types and present weather are converted to the TD-3280 numeric codes. These conversions are performed automatically as a part of the extraction process on the SF-pathway.

The following codes are used to report the sky conditions. The corresponding code used in the CD-144 format is shown in parentheses.

00 = clear or less than 0.1 coverage (0)
01 = thin scattered 0.1 to 0.5 coverage (1)
02 = scattered 0.1 to 0.5 coverage (2)
03 = thin broken 0.6 to 0.9 coverage (4)
04 = broken 0.6 to 0.9 coverage (5)
05 = thin overcast 1.0 coverage (7)
06 = overcast 1.0 coverage (8)
07 = obscuration 1.0 coverage (X or -)
08 = partial obscuration <1.0 coverage (blank)
09 = unknown

The following codes are used to report the cloud types for all levels and obscuring phenomena. The corresponding code used in the CD-144 format is shown in parentheses. If no code follows the description, then there is no corresponding code in the CD-144 format. The overpunch characters in the CD-144 format are represented by X/n where n is an integer. An overpunch character as it appears in an ASCII file is also shown.

Cloud types
- 00 = none (0)
- 11 = cumulus (4)
- 12 = towering cumulus
- 13 = stratus fractus (X/2 or K)
- 14 = stratus cumulus lenticular
- 15 = stratus cumulus (3)
- 16 = stratus (2)
- 17 = cumulus fractus (X/4 or M)
- 18 = cumulonimbus (5)
- 19 = cumulonimbus mammatus (X/5 or N)
- 21 = altostratus (6)
- 22 = nimbostratus (X/6 or O)
- 23 = altocumulus (7)
- 24 = altocumulus lenticular
- 28 = altocumulus castellanus (X/7 or P)
- 29 = altocumulus mammatus
- 32 = cirrus (8)
- 35 = cirrocumulus lenticular
- 37 = cirrostratus (9)
- 39 = cirrocumulus (X/9 or R)

Obscuring phenomena
- 01 = blowing spray
- 03 = smoke and haze
- 04 = smoke
- 05 = haze
- 06 = dust
- 07 = blowing dust
- 30 = blowing sand
- 36 = blowing snow
- 44 = ground fog
- 45 = fog
- 48 = ice fog
- 50 = drizzle
- 60 = rain
- 70 = snow
- 76 = ice crystals
- 98 = obscuring phenomena other than fog, prior to 1984 (X or -)

The code definitions for present weather conditions are presented below. They are divided into general categories and each category is further divided for specific weather conditions. Dashes in a field indicate that there is no definition for that code. The 8-digit CD-144 format weather conditions are converted to the 2-digit TD-3280 category.

	1X - Thunderstorm, Tornado, Squall	2X - Rain, Rain Shower, Freezing Rain
X = 0	thunderstorm - lightning and thunder	light rain
= 1	severe thunderstorm - frequent intense lightning and thunder	moderate rain
= 2	report of tornado or water spout	heavy rain
= 3	light squall	light rain showers
= 4	moderate squall	moderate rain showers
= 5	heavy squall	heavy rain showers
= 6	water spout	light freezing rain
= 7	funnel cloud	moderate freezing rain
= 8	tornado	heavy freezing rain
= 9	unknown	unknown

	3X - Rain Squalls, Drizzle, Freezing Drizzle	4X - Snow, Snow Pellets, Ice crystals
X = 0	light rain squalls	light snow
= 1	moderate rain squalls	moderate snow
= 2	heavy rain squalls	heavy snow
= 3	light drizzle	light snow pellets
= 4	moderate drizzle	moderate snow pellets
= 5	heavy drizzle	heavy snow pellets
= 6	light freezing drizzle	light snow crystals
= 7	moderate freezing drizzle	moderate snow crystals
= 8	heavy freezing drizzle	heavy snow crystals
= 9	unknown	unknown

	5X - Snow Shower, Snow Squalls, Snow Grains	6X - Sleet, Sleet Shower, Hail
X = 0	light snow showers	light ice pellet showers
= 1	moderate snow showers	moderate ice pellet showers
= 2	heavy snow showers	heavy ice pellet showers
= 3	light snow squalls	light hail
= 4	moderate snow squalls	moderate hail
= 5	heavy snow squalls	heavy hail
= 6	light snow grains	light small hail
= 7	moderate snow grains	moderate small hail
= 8	heavy snow grains	heavy small hail
= 9	unknown	unknown

	7X - Fog, Blowing Dust, Blowing Sand	8X - Smoke, Haze, Blowing Snow, Blowing Spray, Dust
X = 0	fog	smoke
= 1	ice fog	haze
= 2	ground fog	smoke and haze
= 3	blowing dust	dust
= 4	blowing sand	blowing snow
= 5	heavy fog	blowing spray
= 6	glaze	dust storm
= 7	heavy ice fog	--
= 8	heavy ground fog	--
= 9	unknown	unknown

	9X - Ice Pellets	
X = 0	light ice pellets	
= 1	moderate ice pellets	
= 2	heavy ice pellets	
= 3	--	
= 4	--	
= 5	--	
= 6	--	
= 7	--	
= 8	--	
= 9	unknown	

RAMMET METEOROLOGICAL DATA

This format accommodates several dispersion models: BLP, RAM, ISCST, MPTER, CRSTER, and COMPLEX1. The file contains two types of records, the first is a header record and the second is the meteorological data. The second contains the data for one 24-hour period (midnight to midnight) and is repeated until all data are listed. The data are written unformatted to the file.

The format of the header record is

```
READ(u) ID1,IYEAR1,ID2,IYEAR2
        │    │      │   │
        │    │      │   └─ Last 2 digits of beginning year of mixing
        │    │      │      height data.
        │    │      │
        │    │      └─ 5-digit station identification of mixing
        │    │         height data.
        │    │
        │    └─ Last 2 digits of beginning year of hourly
        │       surface data.
        │
        └─ 5-digit station identification of hourly
           surface data.
```

The format of the meteorological records are

```
READ(u)  IYEAR,MONTH,IDAY,PGSTAB,SPEED,TEMP,FLWVEC,RANFLW,MIXHGT
         │     │     │    │      │     │    │      │      │
         │     │     │    │      │     │    │      │      └─ Array of mixing
         │     │     │    │      │     │    │      │         heights (m)
         │     │     │    │      │     │    │      │
         │     │     │    │      │     │    │      └─ Array of randomized
         │     │     │    │      │     │    │         flow vectors (to
         │     │     │    │      │     │    │         nearest degree)
         │     │     │    │      │     │    │
         │     │     │    │      │     │    └─ Array of flow vectors (to
         │     │     │    │      │     │       nearest 10 degrees)
         │     │     │    │      │     │
         │     │     │    │      │     └─ Array of temperatures (degrees
         │     │     │    │      │        Kelvin)
         │     │     │    │      │
         │     │     │    │      └─ Array of wind speeds (m/s)
         │     │     │    │
         │     │     │    └─ Array of Pasquill stability categories
         │     │     │
         │     │     └─ Day of month (1-31)
         │     │
         │     └─ Month of year (1-12)
         │
         └─ Last 2 digits of year
```

The DIMENSION statements used to define the arrays are

```
DIMENSION PGSTAB(24),SPEED(24),TEMP(24),FLWVEC(24),RANFLW(24),MIXHGT(2,24)
```

The first index in the MIXHGT array controls which of the two mixing height values is referenced. MIXHGT(1,i) refers to the rural mixing height values, where i equals from 1 to 24 and refers to hour of day in local standard time. MIXHGT(2,i) refers to the urban mixing height values.

Preset values are used to indicate missing data, they are

PGSTAB	0
SPEED	-9
TEMP	-99
FLWVEC	-99
RANFLW	-99
MIXHGT	-999

CALINE-3 METEOROLOGICAL DATA

This format is specific to the CALINE-3 dispersion model. The file contains only one type of formatted data record, one for each hour. The format of the record is

```
READ(u,f) WNDSPD,WNDDIR,PGSTAB,MIXHGT,BCKGRD
          |      |      |      |      |
          |      |      |      |      └─ Background concentration (ppm)
          |      |      |      |
          |      |      |      └─ Mixing height (m)
          |      |      |
          |      |      └─ Pasquill Stability category
          |      |
          |      └─ Wind direction (to nearest degree)
          |
          └─ Wind speed (m/s)

FORMAT( F3.0,F4.0,I1,F6.0,F4.0 )
```

The preset values to indicate missing date are

WNDSPD	-9
WNDDIR	-99
PGSTAB	0
MIXHGT	1000
BCKGRD	0

RTDM METEOROLOGICAL DATA

This format is specific to the RTDM dispersion model (default). The file contains only one type of formatted data record, one for each hour. The format of the record is

```
READ(u,f) IYEAR,IJDAY,IHOUR,WNDDIR,WNDSPD,MIXHGT,PGSTAB,TEMP
```

Temperature (F)

Pasquill category

Mixing height (m)

Wind speed (miles/hr)

Wind direction (degrees)

Hour of day (LST)

Julian day of year

Last 2 digits of year

```
FORMAT( I2,I3,I2,1X,F6.0,F6.1,2F6.0,F6.1 )
```

The input variables listed above are the only ones allowed by current regulatory guidance. The RTDM dispersion model provides for specification of other meteorological variables but these require quite special meteorological observations, or at the very least an intimate knowledge of the meteorological conditions appropriate to the dispersion problem to be modeled.

The preset values to indicate missing data are,

WNDDIR	-999
WNDSPD	-999
MIXHGT	-999
PGSTAB	-999
TEMP	-999

16-SECTOR JOINT FREQUENCY FUNCTION

For the dispersion models VALLEY, ISCLT and CDM16, the input file describing the meteorological conditions is a joint frequency function. The frequency function is constructed using 16 wind direction sectors, with the first 22.5° sector centered on winds from the North (increasing clockwise), six wind speed classes and six stability classes. The wind speed classes are 0-3, 3-6, 6-10, 10-16, 16-21 and >21 kts. The Pasquill stability categories for the CDM16 dispersion model are grouped into classes as,

Class	Pasquill category	Remarks
1	A	Very unstable conditions
2	B	Moderately unstable conditions
3	C	Slightly unstable conditions
4	D (daytime)	Neutral conditions (sunrise to sunset)
5	D (nighttime)	Neutral conditions (sunset to sunrise)
6	E-F	All stable conditions

The Pasquill stability categories for the ISCLT and VALLEY dispersion models are grouped into classes as,

Class	Pasquill category	Remarks
1	A	Very unstable conditions
2	B	Moderately unstable conditions
3	C	Slightly unstable conditions
4	D	Neutral conditions
5	E	Stable conditions
6	F	Very stable conditions

The format of the meteorological file is

```
LOOP ON I=1,6
LOOP ON K=1,16

READ(u,f)  FREQ( (I,J,K),J=1,6 )
           |       |   |  |
           |       |   |  └─ Index associated with wind speed class
           |       |   |
           |       |   └─ Index associated with wind direction sector
           |       |
           |       └─ Index associated with stability class
           |
           └─ Frequency of occurrence (decimal), of stability class I, with
              wind speed class J, for wind from wind sector K

FORMAT( 9X,6F9.6 )
```

Hence the meteorological files consist of 96 records, the first 16 are for stability class 1, the next 16 are for stability class 2, and so forth.

36-SECTOR JOINT FREQUENCY FUNCTION

For the dispersion model CDM36, the input file describing the meteorological conditions is a joint frequency function. The frequency function is constructed using 36 wind direction sectors, with the first 10° sector centered on winds from the North (increasing clockwise), six wind speed classes and six stability classes. The wind speed classes and stability classes are the same as described above for the construction of the 16-sector joint frequency function.

The format of the meteorological file is

```
LOOP ON I=1,6
LOOP ON K=1,36

READ(u,f)  FREQ( (I,J,K),J=1,6 )
           |      |   |   |
           |      |   |   └ Index associated with wind speed class
           |      |   |
           |      |   └ Index associated with wind direction sector
           |      |
           |      └ Index associated with stability class
           |
           └ Frequency of occurrence (decimal), of stability class I, with
             wind speed class J, for wind from wind sector K

FORMAT( 9X,6F9.6 )
```

Hence the meteorological files consist of 216 records, the first 36 are for stability class 1, the next 36 are for stability class 2, and so forth.

GLOSSARY

ABNORMAL JOB TERMINATION -- this statement, if found in the general report file, indicates that an error condition was detected and further processing has been inhibited.

ASCII -- American Standard Code for Information Interchange.

AUD Input -- an input image used to add variables to the default list of variables being tracked on the UA, SF or OS pathway during quality assessment.

Audit Summary -- a written summary of the results for the variables tracked (audited) during quality assessment.

Audit Variables -- variables that are tracked during quality assessment.

BLP -- Buoyant Line and Point source dispersion model, from Appendix A of the modeling guideline (EPA, 1986).

Bowen Ratio -- ratio of the upward flux of sensible heat to the energy flux used in evaporation; a measure of the relative evaporative power of the atmosphere.

CD-144 Format -- Card Deck-144 data format available from NCDC for National Weather Service surface observations commonly used for dispersion models. Each record represents an 80-column "card image".

CDM -- Climatological Dispersion Model, from Appendix A of the modeling guideline (EPA, 1986).

COMPLEX1 -- A multiple source complex terrain dispersion model, used as a second level screening model in regulatory modeling, (EPA, 1986).

Convective Mixing -- mixing of atmospheric properties as a result of surface heating.

CRSTER -- A single source dispersion model, from Appendix A of the modeling guideline (EPA, 1986).

Dispersion Model -- A group of related mathematical algorithms used to estimate (model) the dispersion of pollutants in the atmosphere due to transport by the mean (average) wind and small scale turbulence.

DOS -- Disk Operating System.

EBCDIC -- Extended Binary Coded Decimal Interchange Code.

EOF -- End-of-File.

EPA -- U. S. Environmental Protection Agency.

Error message -- a message written by the processor to the error/message file whenever an error is encountered that will inhibit data processing.

Error/Message File -- a file used in all stages of processing for storage of messages written by the processor.

Extracted Data File -- the file resulting from Stage 1 processing for storage of data retrieved from a magnetic medium (disk or tape).

Extraction Process -- the process of retrieving data from a magnetic medium.

Fatal Error -- any error which inhibits further data processing on a pathway or stops the MPRM processor.

File Headers -- records written by the processor at the top of files during Stage 1 and Stage 2 processing. These records contain the input images from individual pathways in addition to supplementary records tracking the history of the data set.

Flow Vector -- The direction towards which the wind is blowing.

General Report File -- a file written either to the default output device or a disk file summarizing the processor results.

GMT -- Greenwich Mean Time, the time at the 0° meridian.

Harmonic Average Wind Speed -- $[\Sigma(1/u_i)/N]^{-1}$, where N is the total number of observations and u_i is the i^{th} wind speed observation. The harmonic average wind speed is used by the CDM dispersion model in computing the effects of dilution.

Height Intervals -- heights used for reporting the results of quality assessment of upper air data (see also Interval Thickness).

Hypsometric Formula -- a determination of the height difference between any two pressure levels based on hydrostatic balance, which requires the mean virtual temperature of the layer.

Information(al) message -- any message written to the error/message file that reports the status of the processing and further data processing is not affected.

Initial Status Report -- the first page of the general report for Stage 1 and Stage 2 processing.

Input Command Structure -- the syntax and sequence of the input images.

Input Image -- user supplied input, read through the default input device, controlling MPRM data processing.

Interval Thickness -- the height difference used in summarizing the quality assessment results of upper air data (see also Height Interval).

IQA -- Input to Quality Assessment, an input image that defines the output file to receive extracted data. This file also serves as the input file for the first pass through quality assessment of the data.

ISCST -- Industrial Source Complex - Short Term dispersion model, from Appendix A of the modeling guideline (EPA, 1986).

JB -- JoB, the 2-character code indicating that all fields on the input image pertain to the overall operation of the processor.

JB Data -- collective term for all input images that begin with the 2-character code JB.

JB Pathway -- collective term for logic associated with deciphering input images beginning with the JB character code.

JCL -- Job Control Language, an IBM mainframe's operating system control language for batch jobs.

Joint Frequency Function -- the joint frequency of wind direction sector, wind speed class and stability category (see also STAR).

Kb -- kilobyte, 1000 bytes

Keyword -- the 3-character codes that follow immediately after the pathway ID in the input run stream data.

Library Routines -- a collection of subroutines that are called by two or more subroutines and/or main program.

LST -- Local Standard Time.

Math Co-processor -- a computer chip used to speed up floating point arithmetic in a personal computer.

Mb -- megabyte, one million bytes.

Merged Data File -- the file produced by Stage 2 processing consisting of available upper air and mixing height data, surface observations and on-site data for a specified period of time.

Merge Processing -- the process by which data from the 3 pathways (UA, SF, OS) are combined to produce a merged data file.

Meteorological Data File -- any file containing meteorological data, whether it be upper air soundings, mixing heights, surface observations or on-site data, or any combination of these.

Missing Value -- alphanumeric character(s) that represent breaks in the temporal or spatial record of an atmospheric variable.

Mixing Height -- the depth through which atmospheric pollutants are typically mixed by dispersive processes.

Monthly Mean Value -- a one-month arithmetic average of a meteorological variable.

MPDA -- Meteorological Processor for Diffusion Analysis, the predecessor to MPRM, available in UNAMAP version 6.

MPRM -- Meteorological Processor for Regulatory Models, the software described in this document.

MPTER -- Multiple Point source dispersion model with TERrain adjustment, from Appendix A of the modeling guideline (EPA, 1986).

MR -- MeRge, the 2-character code indicating that all fields on the input image pertain to combining of the data from the three pathways into a single unformatted file.

MR Data -- collective term for all input images that begin with the 2-character code MR.

MR Pathway -- collective term for logic associated with deciphering input images beginning with the MR character code.

NCDC -- National Climatic Data Center, the federal agency responsible for distribution of the National Weather Service upper air, mixing height and surface observation data.

NTIS -- National Technical Information Services, the agency responsible for distribution of technical information, including UNAMAP products.

NWS -- National Weather Service.

OQA -- Output from Quality Assessment, an input image that defines the output file to receive data that have gone through quality assessment. This file is also used as the input file for Stage 2 processing.

On-site Data -- data collected from a meteorological measurement program operated in the vicinity of the site to be modeled in the dispersion analysis.

Opaque Sky Cover -- the amount of sky cover, expressed in tenths, that completely obscures all that might be above it.

OS -- On-Site, the 2-character code indicating that all fields on the input image pertain to the processing of on-site data

OS Data -- collective term for all input images that begin with the 2-character code OS, also used to collectively refer to on-site data processed.

OS Pathway -- collective term for logic associated with deciphering input images beginning with the OS character code.

Overlay -- one or more subprograms that reside on disk and are loaded into memory only when needed.

Pasquill Stability Categories -- a classification of the dispersive capacity of the atmosphere, originally defined using surface wind speed, solar insolation (daytime) and cloudiness (nighttime). They have since been reinterpreted using various other meteorological variables.

Pathway -- one of the five major processing areas in MPRM. These are JB, OS, SF, UA, and MR (see these entries in this section for a description).

PC -- Personal Computer.

Processing Methodologies -- options controlling Stage 3 processing.

Quality Assessment -- judgment of the quality of the data.

Quality Assessment Check -- determining if the reported value of a variable is reasonable (see also Range Check).

Quality Assessment Message -- message written to the error/message file when a data value is determined to be suspect.

Quality Assessment Violation -- occurrences when data values are determined to be suspect (see also Range Check Violation).

RAM -- (1) Random Access Memory on a personal computer.
(2) a multiple source dispersion model from Appendix A of the modeling guidance, (EPA, 1986).

RAMMET -- Meteorological processor program used for regulatory applications capable of processing twice-daily mixing heights (TD-9689 format) and hourly surface weather observations (CD-144 format) for use in dispersion models such as CRSTER, MPTER and RAM, (EPA, 1986).

Range Check -- determining if an observation of a variable falls within predefined upper and lower bounds.

Range Check Switch -- parameter whose value indicates whether to include or exclude the upper and lower bounds during range checks.

Range Check Violation -- determination that the value of a variable is outside range defined by upper and lower bound values (see also Quality Assessment Violation).

Raw Data File -- any file which has not been processed by MPRM

Regulatory Applications -- dispersion modeling involving regulatory decision-making as described in the Guideline on Air Quality Models (Revised), (EPA, 1986).

Regulatory Model -- a dispersion model that has been approved for use by the regulatory offices of the EPA (EPA, 1986).

Reporting Procedures -- options available in Stage 3 processing for reporting the availability of meteorological data for the selected dispersion model.

Roughness Length -- see Surface Roughness Length

RTDM -- Rough Terrain Dispersion Model, complex terrain dispersion model used as a third level screening model used in regulatory dispersion modeling (EPA, 1986).

Run Stream -- collectively, all input images required to process data in MPRM.

σ_a -- standard deviation of the horizontal wind direction fluctuations.

σ_e -- standard deviation of the vertical wind direction fluctuations.

σ_w -- standard deviation of the vertical wind speed fluctuations.

Scan report -- the report generated by MPRM processor summarizing the contents of a magnetic tape. This report is generated only if extraction is requested and no data are extracted from the tape.

SF -- SurFace, the 2-character code indicating that all fields on the input image pertain to the processing of NWS hourly surface weather observations.

SF Data -- collective term for all input images that begin with the 2-character code SF, also used to collectively refer to NWS hourly surface weather observations.

SFC Input-- keyword indicating on-site data supplied to the processor, consisting of surface albedo, Bowen ratio, and surface roughness length as a function of wind direction and time of year. This is an optional input.

SF Pathway -- collective term for logic associated with deciphering input images beginning with the SF character code.

Stage 1 Processing -- the process of extracting or retrieving meteorological data from raw data files and subsequent quality assessment of the data, and all reports and files generated during this process.

Stage 2 Processing -- the process of combining or merging the three types of meteorological data into an unformatted file, and all reports and files generated during this process.

Stage 3 Processing -- the process of preparing meteorological data, processed in Stage 2, for use by a dispersion model, and all reports and files generated during this process.

Standard Reporting Levels -- mandatory pressure levels (and corresponding measured atmospheric quantities) in a NWS upper air sounding.

STAR -- (STability ARray) stability and wind rose summary, a joint frequency distribution summary of stability category, wind speed and wind direction. The STAR data are used as input for several long-term dispersion models such as CDM and ISCLT.

Station Identification -- an integer or character string used to uniquely identify a station or site as provided in the upper air (TD-5600 and TD-6201), mixing height (TD-9689), and surface weather (CD-144 and TD-3280) data formats available from NCDC. There are no standard station numbers for on-site data and the user may include any integer or character string up to eight digits or characters.

Storage Formats -- For magnetic tapes, the formats available from NCDC for storing upper air and surface observations. See TD-1440, TD-3280, TD-5600, TD-6201, TD-9689 and CD-144. For on-site data 'storage formats' refers to the format of the data on the input file.

Subdirectory -- a directory below the root, or highest level, directory or another subdirectory, used for organization of files on a storage medium such as a PC hard disk.

Surface Albedo -- fractional amount of radiation incident on a surface that is reflected away from the surface.

Surface Weather Observations -- a collection of atmospheric data on the state of the atmosphere as observed from the earth's surface. In the U.S. the National Weather Service collect these data on a regular basis at selected locations.

Surface Roughness Length -- height at which the wind speed extrapolated from a near-surface wind speed profile becomes zero.

TD-1440 Format -- a format available from NCDC for summarizing NWS surface observations in an 80-column format; the CD-144 format is a subset of this format. This format has been superseded by the TD-3280 format.

TD-3280 Format -- the current format available from NCDC for summarizing NWS surface weather observations in an elemental structure, i.e., observations of a single atmospheric variable are grouped together for a designated period of time.

TD-5600 Format -- a format available from NCDC for reporting NWS upper air sounding data. This format has been superseded by the TD-6201 format.

TD-6201 Format -- the current format available from NCDC for reporting NWS upper air data. The file structure is essentially the same as the TD-5600 format except that there is more quality assurance information.

TD-9689 Format -- the format available from NCDC for mixing heights estimated from morning upper air temperature and pressure data and hourly surface observations of temperature.

Temperature lapse rate -- the fall of temperature per unit height, and is taken as positive when temperature decreases with height.

Total Sky Cover -- the amount of sky, expressed in tenths, covered by a combination of transparent and opaque clouds or obscuring phenomena.

Turbulence -- The irregular "eddy" motions in fluids, whether liquid or gaseous, which cause an irreversible mixing of fluid properties between neighboring parcels.

UA -- Upper-Air, the 2-character code indicating that all fields on the input image pertain to the processing of the twice-daily mixing height data and the upper air data.

UA Data -- collective term for all input images that begin with the 2-character code UA, also used to collectively refer to mixing height and upper air data processed.

UA Pathway -- collective term for logic associated with deciphering input images beginning with the UA character code.

UNAMAP -- User's Network for Applied Modeling of Air Pollution, a collection of dispersion models and closely related support utilities available through NTIS.

Unformatted File -- a file written without the use of a FORTRAN FORMAT statement.

Upper Air Data (or soundings) -- meteorological data obtained from balloon-borne instrumentation that provides information on pressure, temperature, humidity, and wind away from the surface of the earth.

VALLEY -- a complex terrain dispersion model used as a first level screening model in regulatory dispersion modeling, (EPA, 1986).

Warning Message -- a message written by the processor to the error/message file whenever a problem arises that may inhibit further data processing.

Wind Shear -- the change in wind velocity with height.

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